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EDUCATING THE WORKER.

During the last few years those placed in charge of men have shown more interest in the education which these men have, and consequently we have heard more about what this education should be and how it should be given. Much interest has been shown in the work of the training schools, particularly those which attempt to give a technical training. The subject has been discussed at various times by various organizations, some of which have special committees for investigating educational methods; and there has even been formed a new society, the object of which is to promote industrial education. The number of shop managers or gang foremen who prefer a man that does his work by rote without knowing why, has certainly diminished. The greater number of such men to-day realize that the knowledge of why a thing behaves as it does, or why such and such a piece of work is performed in just one way, does help the man who must do the work.

The realization that the education and improvement of his employés benefit the employer himself, has led to various schemes for assisting the men, particularly the younger ones, in securing a certain amount of educational training. They are encouraged to attend night schools or take correspondence courses, and in this way obtain that training which others more fortunately situated get before going to work.

But while this sort of study should be encouraged, it must not be overlooked that each man has his limitations, and that sometimes a good deal of time and energy and money are wasted in such ways. A man who is working the full day can not bring as much energy to his studies as the student who has no labor; and not every boy in the shop is strong enough to work all day and then study half the night. Discrimination is necessary in regulating this matter; otherwise more harm than good will be done.

An interesting report upon this subject was made recently by an English engineering society which had taken some steps to encourage the young man to study. Realizing that some way of checking the results was necessary, this association adopted a system of marking the engineering apprentices who were studying, and it is the information gained in this way which was given in the report referred to. These young men not only attend night classes, but they are given a certain amount of time during the day for study. In this system the marking is based upon periodical examinations, and the privileges granted to the apprentice depend considerably upon the results of his examinations. Curves showing the progress of each student are kept,

which, it is thought, indicate how much good is being done. In summing up, the report says that one thing is clearly shown by the curves, and that is that the number of apprentices who do efficient class work forms a small percentage of the whole, and excepting a few cases, the work is of a rudimentary character. Hardly more than one apprentice in five showed any results at all; others were not affected either for good or bad. For this reason the report urged that more attention should be paid to selecting those who were doing good work, and that these should be given special facilities, and that those who accomplished nothing should not be encouraged to go on. Only an exceptionally strong youth, strong both mentally and physically, can make any great headway by evening study and at the same time work regularly and well in the shop. These views sound perfectly reasonable, for while it is well that we should have reached the stage where an educated man is looked upon as capable of good work, yet we should not go too far the other way in the attempt to give a good education to every worker. The thing to do is to give the young man an opportunity to improve himself. If he accepts this and makes good use of it, let him continue; if he does not and simply uses it as an excuse for slighting his labor, he can not be brought around too sharply. It is unfortunate that many men are so situated that they have not a very good opportunity for improving themselves, but the conditions are constantly improving in this direction.

PHYSICS, THE FOUNDATION FOR ELECTRICAL ENGINEERING TRAINING.

During the past few years there have been numbers of text-books on general engineering subjects, many of them excellent in their way, and the greater number having some special features of value. This is particularly true of the electrical branch, which perhaps has been more prolific in producing such text-books than any other. That so many books have been thought desirable is due to the fact that many instructors have not found any book which seemed to present the subject in just the way which seems best to them. This is notably true of the more advanced books dealing with alternating currents, a study which has offered more opportunities for differences in the method of treatment than the study of direct currents. One reason for this is the opportunity offered for the use of mathematics in the study of the former subject. In the study of direct currents the fundamental phenomena are so simple that there is little excuse for dragging in higher mathematics. In alternating currents, however, due to certain physical limitations, the underlying phenomena seem to the beginner, who approaches the subject from the mathematical viewpoint, more complicated, and, moreover, from the mathematician's presentation of the phenomena, he is apt to see in the study complications which do not actually exist, but result simply from the method of treatment. The phenomena, in fact, are identical with those met in direct-current circuits. No new reaction occurs, although certain ones take on more prominence due to the periodical starting and stopping of the current, but even these have their exact counterparts in other reactions which play equally important parts in direct-current phenomena. That this state of affairs is bad and unnecessary is the stand taken in the forcible paper by Mr. Lamar Lyndon, which is published elsewhere in this issue, and which pleads for the physical study of alternating currents before applying the mathematical analysis. Mr. Lyndon takes the view just expressed; that alternating-current phenomena are not more complicated than those of direct currents, and that the apparent complications met in our studies are due to the limitations imposed upon us in constructing measuring apparatus, but these limitations are not sufficient justification for the mathematical treatment which is generally given.

Mr. Lyndon's contention is that Ohm's law holds in alternating as well as in direct-current circuits, provided the values used are those which occur simultaneously. Since this is the true condition of affairs, a complete understanding of this condition is necessary if the student is to secure a thorough grasp of the subject. He should be taught to think of what is actually occurring, and not in the methematical equations and graphical diagrams which are so useful in arriving at numerical values. These methods of analysis are invaluable in themselves, but they should be applied only after the physical reactions are understood, and not for the purpose of leading up to the physical study.

It seems, indeed, strange that the limitations imposed upon us in designing apparatus for measuring pulsating effects should have resulted in giving so many a distorted view of an important branch of electrical science. Because our instruments measure the average effects is not sufficient reason why, in the study of the subject, these effects should be dealt with primarily, and what is actually taking place should be overlooked. Yet the student is taught that a new factor enters into the equation expressing Ohm's law, this factor being the cosine of the angle of lag of the current with respect to the electromotive force. Can he be blamed, then, for thinking that the current is actually trailing along behind the electromotive force, and never catches up to it? He is taught that only a part of the current flowing is really doing work, and the subject naturally becomes difficult to understand when he tries to form a mental image of what is actually going on, as his mind is concentrated on two values which do not exist at the same time. As a matter of fact, the only value of any electromotive force which can any way affect the rate of flow of electricity is one which exists at the instant at which the current flow is to take place. That value of potential existing a quarter of a period, or ten degrees, or one-thousandth of a second, either before or after the particular flow of current under consideration, has no influence on that current. The things do not exist at the same time, and have nothing whatever to do with one another. But, unfortunately, these facts are seldom sufficiently emphasized; and the necessity for acquiring more or less facility in predicting results, for which purpose mathematical and graphical analyses are so useful, usually leads to a concentration of the attention on these

methods of treatment, and the student is left, more or less, to build up his own idea of what is actually going on. Can it be wondered if his image is a complicated geometrical figure in which a current is acting in a direction at an angle to a force, that only a part of this current is useful, and that the other part—the so-called "wattless component"—slips around the circuit without ever doing anything useful and merely serves to heat the apparatus. Indeed, not infrequently even this objectionable feature of the "wattless current" is overlooked. It seems to be a sort of perpetual motion, the "wattless" current flowing back and forth in an idle sort of way, and only being put to work by some device which will twist it into the proper direction.

It is frequently said that one of the most necessary qualities of the engineer is a fund of common sense. While it is necessary for him to understand the science upon which his special branch of the subject is founded—and he must, of course, be able to use his knowledge in a practical way—he must, first of all, know the facts. How can it be expected that a student will get a common sense understanding of alternating currents if he is not taught the facts? Let him first be told what is actually taking place; that alternating currents are simply a special form of direct currents in which the current is started, stopped and reversed at frequent intervals; but that this does not in any way change the state of affairs. Let him be thoroughly impressed with the truth of the fundamental electric laws of Ohm and Kirchhoff; and do not introduce him to the mathematical study of harmonic vibration until he has fully grasped these facts. It is unfortunately true that too many text-books start the subject with a discussion of the measuring apparatus, as when this is done it can hardly be expected that the student will avoid all the pitfalls that lie in his path. If the instructor finds it necessary to perform experiments and use actual values, let him use an oscillograph, which gives instantaneous values that can be properly introduced into the fundamental equations.

CHARACTERISTICS OF THE FLAMING ARC LAMP.

In a recent issue of the Bulletin de La Société Internationale des Electriciens, Professor A. Blondel, who has contributed in no little degree to the development of the so-called "flaming arc" lamp, discusses the recent developments in this field of lighting, and describes some of the interesting peculiarities of this form of lamp. He first points out the necessity for some departure in the design of arc lamps because of the little possibility of improving the efficiency of the process of producing light by heating the carbon to incandescence. It unfortunately happens that carbon approaches very closely the so-called "ideal black body," and hence is one of the best radiators of energy, but it is a property of black-body radiation that nearly all the energy is given off in long wave-lengths, and but a small part of one per cent is given off in those wave-lengths which are useful light. The higher the temperature, of course, the more efficient the process, but even a very great improvement brought about in this way still leaves the process an exceedingly inefficient one, only about one per cent of the energy at the best being converted into light; hence some better method of producing light is desirable, and one available is that which is utilized in the flaming arcs. Materials are added to the carbon which produce a luminous flame; in the pure carbon arc, practically all the light comes from the incandescent electrodes.

These luminous arcs are said to show three effects: There is the luminosity of the ionized vapors which conduct the current. This effect can not be produced merely by raising the temperature of the vapors, but only takes place when there is either chemical or electrical reaction going on. The luminescent vapors show the characteristic spectra of the materials added to the carbon. Secondly, there is the incandescence of the electrode, and lastly that portion of the incandescent vapor in excess of what is required to conduct the current seems to give practically a continuous spectrum. In securing these effects certain material must be added to the carbon which are easily ionized, and which will emit useful rays of light. Materials suitable for this are salts of the calcium group. The addition may be made in three ways: Electrodes may be made of the pure chemicals, or carbon may be mixed with the material so as to produce a homogeneous mixture, or a cored carbon is used in which the impregnated portion is surrounded by a coating of pure carbon. The first method has not given very much success; the second method is used by some, while the third is the one which the author has studied specially. This has the advantage that the arc is concentrated on the core and is steady without it being necessary to use electrodes of small diameter. Moreover, the carbon coating furnishes a fairly good conductor for the current. The arc between such electrodes is not subject to violent changes in luminosity, and it is possible to construct a lamp with the two electrodes in a vertical line, which simplifies the lamp somewhat and gives a distribution of light which is uniform around the lamp and not so concentrated downward as when the inclined carbons are used. Such lamps are said to give a much greater luminous efficiency than any other practical lamp. In large sizes the efficiency is said to be about twelve-hundredths of a watt per candle. The quality of the light is, of course, more or less under control, but elements belonging to the calcium group seem to be the best, as these not only give out red and yellow rays, but are freer from ultraviolet radiations than the iron or titanium arcs. The efficiency of the flaming arc increases very considerably with an increase in the power of the arc, but steady arcs with currents of from three to five amperes are procurable.

The flaming arc lamp has peculiarities which are of distinct advantage for certain uses, and as these become better known it will take a more important position than that of a striking advertisement. Its color and the enormous quantity of light poured out make it excellent for outdoor night work; it should also prove useful for street illumination and for lighting large open works, such as foundries and forge shops, where the materials used are dark and smoke and dust abound. But in all such uses special care in placing the lamp is needed in order that the intense brilliancy and enormous flux of light may not dazzle the workmen or injure their eyes.

The Electrical Industries in 1907.

A Brief Review of the Important Developments of the Past Year.

THE record made by the electrical industries during the past year was highly creditable. The year started out with a continuation of the activity of 1906 and all branches flourished exceedingly until the fall when the financial flurry, which occurred in October, brought a check which, while it did not offset the extraordinary success of the preceding nine months, still reduced the record for the year below what it would otherwise have been. On the whole the amount of electrical work done was certainly greater than that ever performed in any previous year.

Taking up more in detail the various branches of the electrical industry, a few of what seem to-day to be the most significant advances may be reviewed. The oldest branch of the industry, the telegraph, undoubtedly suffered more during the year, comparatively speaking, than any other, for it not only felt the effects of the financial stringency in the fall, but during the year it had a serious strike of the operators to contend with. This necessarily hampered the two large companies considerably, but they were successful in maintaining fairly satisfactory service until the strikers weakened and gave up the fight. From the public viewpoint the disagreement seemed to be mainly one of wages and hours of work, while the officers of the companies looked upon it as a fight to determine who was to control the business.

Aside from this incident in operation of the telegraph companies, probably the most significant development was the increasing use of printing telegraphic systems. The tendency to-day is fairly well indicated by the record of the Western Union Telegraph Company. This company has adopted the printing telegraph system invented by John C. Barclay, its engineer. This was introduced last year at a few points; the results were so satisfactory that it is now being widely used for trunk-line service. Messages between New York and Boston, Philadelphia, Buffalo, Pittsburg, Chicago and St. Louis are now transmitted in this way while the other towns also are equipped for intercommunication with the same apparatus, and in addition with other cities. By the end of the year the company had about two hundred of these equipments in use; they are operated by girls who are not trained operators, as it has been found that they give better results than the trained men. The transmission is considerably faster than that which can be rendered by hand.

Another feature of the telegraph work is the continued advance in structural methods. More substantial line-work is done so that the work of the company is less interfered with by bad weather.

Among the telegraphic inventions of the year was an automatic system brought out by R. L. Dean. And still another development was the organization of a company to put into operation the Telepost system, which utilizes the Delany rapid telegraph system for transmitting messages from office to office, which messages are then despatched to their destinations by mail.

In wireless telegraphy the most notable incident was the establishment of communication across the Atlantic, Marconi having finally completed his arrangements for putting this system into service. It was opened on the seventeenth of October and since then has been in continual use, certain of the daily papers making a specialty of news transmitted in this way.

Other wireless systems have shown considerable progress, and the adaptation of the oscillating arc for this purpose, which was made during the year, promises to give excellent results. This is due to Poulsen, who also brought out during the year a wireless telephone system. At the close of the year there were about 1,550 wireless telegraph stations in service throughout the world. This system is becoming daily more important in maritime service.

In the telephone branch of the industry no particularly striking event has occurred, although there were certain important developments carried through. The tendency here to standardize apparatus has continued, but this has not been allowed to work to the detriment of the service, and a significant development during the year was the bringing out of a new type of switchboard intended for small stations, which gives as good service as the elaborate and expensive boards installed in large cities, and yet is sufficiently cheap to be available for the small towns, the service of which it will greatly improve. The use of the loaded line has been extended during the year. Here also the tendency is toward more rigid overhead construction. The American Telephone and Telegraph Company has completed the underground system between New York and Philadelphia, and the Boston line as far as New Haven. These lines are now being put into service and, of course, render the company fairly independent of wind and weather for communicating between these points. This company also closed the gap between Kansas City and Denver, so that the Bell companies are now connected up as far West as Salt Lake City.

In automatic telephony the purchase of the Strowger system by the Automatic Electric Company cleared the air somewhat and left two strong companies in control of the field. Several automatic exchanges of some importance were installed during the year, notably one at Omaha for ten thousand subscribers, which is the most recent.

A development in this field, or rather in one closely allied, was the bringing out of a system by E. E. Clement which he calls the "Automanual." This is a semi-automatic system which automatically picks out an idle operator, who, by means of a keyboard, sets up the connections desired. A contract has been made for an installation of this system in Ashtabula, Ohio.

Increased interest has been shown in wireless telegraphy during the year, which was stimulated by the descriptions of the Poulsen system. Valdemar Poulsen, the well-known inventor of the telegraphone, found that by enclosing a Thomson or Duddell singing arc in hydrogen and artificially cooling the electrodes, he could obtain oscillations of a high frequency, running up into the hundred thousands. This arrangement is immediately available for setting up electrical oscillations employed in wireless telegraphy, as was referred to above, and has been used with considerable success for wireless telephony, the effect of the voice being superposed upon the oscillating current in the arc. This system, it is reported, has been used for a distance of 260 miles, and the

telephone world was somewhat surprised when Poulsen announced that he intended to establish transatlantic wireless telephony within the next three months. The de Forest system of wireless telephony has given some creditable performances during the year and is now being given a thorough trial on the United States Navy, where nearly thirty sets have been installed.

The electric lighting field has seen a continued activity in the work of developing and manufacturing improved forms of lamps. Many of the newer types which were novelties a year or two ago have been accepted as commercial devices and are finding fields where they are giving good service. The Cooper Hewitt mercury-vapor lamp and the various types of flaming and luminous-arc lamps no longer excite comment. Lamps of the latter type are being introduced for street lighting, but the enormous amount of light thrown out from each lamp introduces distribution problems which require serious attention.

The incandescent lamp situation has not changed materially. New and supposedly improved forms of lamps were announced during the year and a factory was opened at Cleveland, Ohio, for manufacturing one of the most promising forms. The tantalum lamp is now seen not infrequently, and the tungsten lamp, which is being made at the factory referred to above, will doubtless soon be in wide use. One of the disadvantages of this lamp is its extremely fragile filament, but doubtless this fault will be corrected ere long. A modified carbon-filament lamp was described during the year by H. F. Parker and Walter G. Clark, in which a coating of silicon is deposited on the carbon. Lamps made in this way, it is said, have shown efficiencies of one watt per candle and even better. In this connection a serious problem confronting the lighting companies has arisen. The question is whether they should encourage the manufacturers to bring out lamps requiring the same amount of energy as the old carbon lamps, but giving more light, or should they be in favor of units giving the same amount of light as the old carbon lamps, but taking less energy. It is easier to make the larger lamps, but there seems to be a tendency among illuminating experts to turn to units of lower candle-power. These newer types of lamp, in which the intrinsic brilliancy is high, have emphasized the need for a careful study of lighting problems, and more attention than ever is now paid to the proper location of lamps and the proper shading of them. If, as has been charged, unshaded lamps of high candle-power injure the eye, a considerable improvement in this respect should follow from the attention which the art of illumination has been receiving.

One invention during the year was described which points to a considerable advance, if the published reports are confirmed by later reports. Dr. K. Kuch, of Berlin, found that by replacing the glass tube of the mercury-vapor lamp by a quartz tube, he could greatly increase the density of the current flowing through the lamp. It had been found that the mercury-vapor lamp gave its best efficiency at about 0.6 watt per candle. If the current density were increased, the efficiencies fell off. Dr. Kuch says that by a still further increase in current density, which carries the temperature of the vapor above that which glass can resist, the efficiency again improves and even reaches 0.2 watt per candle, while the spectrum of the light produced is improved, there being a greater proportion of red. The increased drop of potential in the lamp which was brought about in this way makes it possible to reduce considerably the length of the lamp tubes. A tube for 110 volts is only about five inches long and can be mounted horizontally in a casing not larger than that required for an arc lamp.

Connected with the lighting industry is that of power supply. The year has witnessed a continued increasing use of electric power for all purposes. For example, a modern church now makes free use of electric motors, as is shown by a recent installation in Worcester, Mass., where there are five motors for various purposes, aggregating about thirty horsepower. In all lines of work where safety, cleanliness and convenience have any consideration, the electric motor has won increased approval. At the stations themselves there have been no marked changes. The steam turbine is still in much favor, although some large modern stations have installed the reciprocating engine. The gas engine has been tried, but is not yet a considerable factor in central stations, though for such purposes it promises much.

The development of the electric railway has been one of the most remarkable features of the past twenty years of electrical application. In preceding years we have seen it, in turn, drive out the horse and the cable and other forms of street traction. It then displaced the steam locomotive on the elevated lines and made practical the operation of subways. Today no other system is considered for such purposes. The most noteworthy work now in progress is undoubtedly in New York city, where an extension of the subway to Brooklyn was completed, and trains have been put into service between Manhattan and the Borough Hall in Brooklyn. The Belmont tunnels under the East river were also completed and trial trains run. Some of the McAdoo tunnels under the Hudson river have been completed, and work is being rapidly pushed on these as well as on the Pennsylvania tunnels under the same river. These, of course, will be operated electrically and will make a great improvement in the transportation facilities connecting Manhattan Island with its neighbors. In the field of heavier traction significant progress was also made. The New York Central & Hudson River Railroad, which opened its electric zone at the close of the previous year, completed the transformation and removed all steam locomotives from this zone. The operation of the electric system has been exceedingly gratifying with the exception of one rather serious accident in which an electric train was derailed. The New York, New Haven & Hartford Railroad, which has installed the single-phase system on its New York section, also put this into service, thus completely removing the steam locomotive from that section of New York. The West Shore road put into service an electric system between Syracuse and Utica, while the Erie Railroad opened a section of its road near Rochester, N. Y. These, with the exception of the New Haven system, are all third-rail. The latter uses the overhead, catenary suspension, though the locomotives operate on direct-current while on the New York Central's tracks. The single-phase system has been introduced elsewhere, one notable installation being on the Spokane & Inland Railway, a branch of the Inland Empire System, Washington, where it is reported to be giving excellent service. So far the polyphase system has not made any progress in this country, but this was selected for an important Austrian tunnel where the traffic and grades are heavy.

Another significant development during the year was the announcement that the Southern Pacific Railway had secured Frank J. Sprague to report upon the feasibility of installing an electric system on one of the steep mountain sections of this road. Practically all the traffic for

California crosses this section, and to provide for future growth it will be necessary to adopt a system which will increase the carrying capacity of the present road, or else to build an alternative line. Mr. Sprague's problem is to decide whether an electric system installed on the present line would meet the needs and be feasible. In this connection the results obtained by the operation of the two systems at New York are interesting. W. J. Wilgus, chief engineer for the New York Central road, said at a recent meeting of the American Institute of Electrical Engineers, that although the change had not been brought about as an economic move, the financial results had been much more favorable than had been expected, and these alone would amply justify the change. At the same meeting W. S. Murray, electrical engineer for the New Haven road, said that the results obtained in that portion of the electric zone which had been put into service indicated that when the entire zone was operated electrically the expense of operation would be ten per cent less than by steam. Bearing somewhat on this point was a report of Robert Dahlander, electrical engineer for the Swedish Government, upon a project for electrifying a large section of the government railroads. He selected the single-phase system and estimated that the cost of operating this, using the country's water powers, would bring about a saving of about seven per cent of the cost of operating by steam. In the street railway field there has been substantial growth, and the extension of the interurban systems and the linking together and bringing under central management of such systems have continued. Certain of these systems have now reached very imposing proportions, the total mileage on a single system being 400 or more, and sometimes very expensive construction work is undertaken. These systems enter into direct competition with the steam roads, and no doubt will continue to play an important part in the railroad development in the future.

There has been no unusual development in the field of power. Work begun before at large and important power sites has been continued energetically. This is particularly true in the neighborhood of Niagara Falls, in the southern states and in the northwest. Niagara power is now in use at Rochester, N. Y., and the lines are being rapidly extended to Syracuse. The tendency toward more substantial overhead construction, which has been noted before, still continues, and steel towers are being very generally adopted. One development during the year which promises much in this field is the link or flexible insulator which was described at the Niagara convention of the American Institute of Electrical Engineers by H. W. Buck and E. M. Hewlett. This insulator is built up of earthenware sections linked together, as many sections as are required to withstand the line potential being used. This gives a flexible hanger which is attached to a long cross-arm on the tower and from which the high-tension cable is suspended. It is expected by the inventors that this type of insulator will make possible the raising of line potential to 100,000 volts or more. The maximum potential in use to-day is still about 60,000, although 66,000 has been tried at Michigan. Developments in this field, that of utilizing our water powers and of increasing the economy of transmission, will undoubtedly play very important parts in the country's industry during the next few years.

In the field of electro-chemistry and metallurgy there has been no very great development. The Heroult furnace for smelting iron ore, which was tried last year by the Canadian Government at Sault Ste. Marie, was given a trial in California, where the presence of a certain grade of ore and the lack of coke seemed to make conditions favorable. The first reports of the experiments were excellent. At the fall meeting of the American Electrochemical Society, Dr. Henry Noel Potter described a furnace and method which he had developed for producing silicon monoxide, a very light material which promises to find use in various ways. In this field the study of the corrosion of iron has still received a good deal of attention. The problem of preventing this is, however, yet unsolved.

During the preceding year there had been a great deal of interest shown by the public in the furnishing of public utilities and there was rather a demand for municipal ownership of such services. This demand died down markedly during the year just past, this result being somewhat aided by reports made to various civic bodies by special experts who studied the conditions both in this country and abroad. The most noteworthy of these was the voluminous report made to the National Civic Federation, containing many arguments *pro* and *con*. It was in favor of municipal control rather than ownership, and in this direction considerable progress was made by the appointment of public service commissioners by various states and by the disposition of the public service companies to work in harmony with these bodies.

On April 16 an event of much significance to the engineering world took place. This was the dedication and formal opening of the Engineering Societies Building, in New York, which was presented to the American Institute of Electrical Engineers, the American Society of Mechanical Engineers and the American Institute of Mining Engineers, by Andrew Carnegie. The influence of this magnificent home upon the engineering professions will certainly be very great.

In electrical science no very noteworthy discovery was made, but in that closely allied branch of physics which deals with radioactivity several startling, though expected, discoveries were announced. The scientific world has continued with unabated interest with the study of radioactive phenomena, and one of these workers is Sir William Ramsay. During July he announced that he had found that when a solution of copper sulphate was exposed to the emanation given off by radium, that lithium could then be found in the solution. The only way in which he could account for this was the supposition that it was produced by the degradation of copper, a heavier element of the same chemical group. Sodium and potassium were also found in the solution after the treatment; these may have resulted from some action on the glass. If further work confirms Sir William's experiments this will be the first real transmutation of elements, if exception be made to the production of helium, neon and argon from the degradation of radioactive emanations. The work of the Thomson school of physicists on the corpuscular theories of matter and radioactivity has gone on, and although there has been unabated opposition in certain places, there has been no extraordinary change one way or the other.

At the close of the year science in general, and electrical science in particular, suffered an irreparable loss in the death of Lord Kelvin. This occurred on December 17, and a week later he was buried in Westminster Abbey with appropriate honors. Lord Kelvin, or Sir William Thomson, the name by which he was known when he first won honor and fame, has been called the "father of electrical engineering," a title deservedly won by his scientific and technical skill. To him we owe many fundamental engineering principles, and at his death he was recognized as the leading scientist of the world. His name is engraved deeply on the scientific progress of the Victorian age, the most remarkable period of scientific advance the world has known.

Electrical Affairs in Great Britain During 1907.

By Albert H. Bridge.

THE year 1907 did not open well from the point of view of the electrical industry. The high price of copper during the earlier months, and the uncertainty whether, when, and how far it would fall, caused many to delay the placing of contracts for mains and machinery, which circumstance of necessity caused the year's output of energy, and connection of consumers with all that it means, to be less than otherwise would have been the case.

In the absence of manufacturers' reports on the year's trading, one can do little more than guess whether the volume of trade and the profit thereon have been better than in the unfortunate preceding years, but, as has on several occasions been indicated in these pages, some firms have suffered from the lack of electric traction work in both the tramway and railway departments, while others have turned their attention to some of the branches of general engineering work. At least two large manufacturing companies have substantially written down their capital, one of them for the second time in its history. Some that suffered a year or two ago have regained their former position, but there is reason to believe that others that did well earlier are not doing so well now.

The demand for generating station equipments for lighting and power installations has not been great—indeed, new stations have been few and far between—and extensions of existing works, and more particularly those in the larger cities, have been fairly good. The South Metropolitan Electric Light and Power Company opened its new turbo-generator station at Greenwich, and the Kent Power Company started up its works at Frindsbury. Stepney Council is proceeding just now with what is known as its Blyth's Wharf scheme, at considerable outlay, and at Birmingham, Glasgow, Liverpool and Manchester important additions have been or are being made. The London County Council is still a fairly large customer for power and substation plant, cars, permanent way work, and so forth, connected with its conduit tramways, and it has given out a contract for the experimental equipment of several miles of line between Aldgate and Bow on the G. B. surface-contact system. The necessary equipments are being added to forty-eight cars that will run over this section. The council is also equipping a big car-repairing shop and is going to build some cars as well.

During some months of the year proposals for cooperative working between manufacturers, electricity suppliers and contractors have been commanding a good deal of attention, and continued care has been devoted to the more energetic development of electricity supply business, which must benefit practically every branch of the industry. But gas competition is undoubtedly keener, and electricity works that want to make a profit on their operations find it no easy task when coal prices are advanced, gas illumination is improved and metal-filament lamps are being installed. All, or practically all, engineers appear to be confident that the high-efficiency lamps will in time be a valuable help to them in meeting gas competition, as the opinions of a number of them, expressed in the special illuminating engineering number of the ELECTRICAL REVIEW, September 14 last, showed. Lamp manufacturers have been devoting attention to the matter, of course, and the General Electric Company, Limited, is making preparations for manufacturing wolfram lamps on a large scale at its Robertson lamp works, or thereabouts, at Brook Green. The Sunbeam Lamp Company also is similarly engaged at Gateshead, and during 1908 there may be events of some consequence to the British market and to current consumers. The Bastian-Calvert leading-in wires for incandescent lamps, dispensing with platinum, are now in process of manufacture in London.

AINTREE RACE SPECIAL. LARGEST ELECTRIC TRAIN IN ENGLAND. MARCH 21, 22 AND 23, 1907.

Flame-arc lamps have been very much to the fore, and the makers and electric supply authorities are showing considerable enterprise in their efforts to secure a better consideration of the claims of this method of street illumination than was once meted out to it.

For private installation work the suction gas producer has been in demand. Indeed, at Bradford the corporation engineer reported that it was luring away his power users. He went so far as to advise a rearrangement of power rates, as he regarded that as essential if headway was to be made. The gain of small consumers appeared likely to be more than counterbalanced by the loss of big consumers unless he could offer the latter better inducements to remain. One leading firm that had for years specialized in high-class country-mansion installations found that the wealthy classes were more inclined to put their spare money in motor-cars than in electric lighting.

Edmundson's Electricity Corporation, which owns a large number of provincial town lighting and power systems, and is largely interested in the Lancashire Elec-

tric Power undertaking, has fallen on bad times. Some of its systems showed that consumers were not being increased at anything like a satisfactory rate, and coal prices, metallic-filament lamps, and some other things have been as a weight around its neck. Some of the big power companies are improving, but here again the advance has been most disappointing. That lamentable failure, the South Wales Power undertaking, is splitting up into several small concerns, each of which takes one of the stations. The Yorkshire Electric Power Company will soon reap a certain benefit from the construction in its area of the first calcium carbide factory in England. The constructional works for the Lock Leven water-power scheme are proceeding apace, but this is for the British Aluminum Company's manufacturing requirements, and, as has been indicated in these pages, the company has spread its operations out into Continental Europe during the year for manufacturing its additional requirements pending the completion of the Loch Leven operations. The utilization of aluminum for electrical conductor purposes has been pushed forward both by that company and by Johnson & Phillips, of Charlton, during the year.

New wiring rules were issued by the Institution of Electrical Engineers, and the Home Office circulated a draft of electric light and power regulations relating to factories, and these still occupy attention, and will do so for months yet, before being actually imposed in final revised form.

Large private power plants have been a very gratifying feature of 1907. The equipment of the Lambton collieries in Durham; the Lindal iron mines, for unwatering purposes chiefly, as was explained in the ELECTRICAL REVIEW a few months ago; the Cambrian collieries; tinplate rolling mills in South Wales; large crane equipments for government dockyards and other works; the excellent progress that has been taking place in the installation of electric driving in textile factories in Lancashire and other districts —works of these descriptions form an important part of the year's outstanding developments and are expected to continue to be one of the most fruitful of all fields for years to come. The installation on the steamship Mauretania stands out by itself as an achievement of consequence, for both in point of size and in regard to variety of applications for power and lighting, it is said to be the finest example afloat.

In electrical vehicles something has been done to bring England more up to date, and the electrical omnibuses that are running in London are stated to be giving results which will justify putting many more on the streets as soon as the money can be found to pay for their building.

B. H. Thwaite has been experimenting at the Royal Botanic Gardens, London, in the electrical culture of plants. Dr. Alexander has, with considerable success, continued his electrolytic disinfectant work at Poplar. Tramway experts have been deep in the problems of car braking and rail corrugation. Power-station engineers have been engaged with the big gas-engine failure at Johannesburg, concerning which comment and criticism have been free.

In regard to electric railways, we have witnessed the completion of the London tube and underground systems, and their struggles against all sorts of difficulties. New work has been undertaken in the department of railway signaling which is of great moment. The Midland Railway Company's Heysham-Morecambe single-phase line should now be nearing completion. The train will consist of two motor-cars equipped on the Siemens system and one on that of the British Westinghouse, all three cars being worked as one multiple-unit train, the same control gear operating both classes of equipment. Progress is also reported with the electrical equipment of that other single-phase section, of which so much has been heard in general terms, but concerning the technical details of which so little is divulged, namely, the lines of the London, Brighton & South Coast Company.

The Great Eastern Railway has put down a new power station for its lighting and driving purposes at Stratford, London.

On the Lancashire & Yorkshire system there was an interesting achievement in the early months of the year, on the occasion of the spring race meeting at Aintree. During three days all the special trains for race traffic from Liverpool were worked for the first time by electric power. By the kindness of J. A. F. Aspinall, the general manager of the railway, I am able to give a few particulars, together with the accompanying photograph of one of the "specials." The company had extended its electrical service to Aintree, a distance of between five and six miles. Aintree is a growing residential suburb to the northwest of Liverpool, and is famous for being the spot where the "Grand National" is run. The special trains in question were six in number and were probably the largest and heaviest electric trains ever run in England. They took the place of steam trains of somewhat similar carrying capacity, but whereas with the latter it was necessary to do shunting operations in order that a fresh locomotive could be put on for the return journey, in the case of the electric trains this was avoided. Four of the trains consisted of ten ordinary six-wheeled trailer cars, over the roofs of which cables had been run to connect standard electric motor-cars, placed one at each end; these motor-cars were of the sixty-feet-long type, equipped with four 150-horse-power motors. In this way the company was enabled to utilize a considerable amount of ordinary stock. The other two trains were made up of similar carrying capacity, but using ordinary electric trailer cars. The horse-power of each train nominally can be taken at 1,200, both sets of trains being approximately 460 feet long, capable of seating over 500 passengers and weighing about 230 tons.

The London & North Western Railway secured its Parliamentary powers for electric lines (part tube) between Euston and Watford (cost, $12,500,000), and many a manufacturer would be benefited if this work came along soon.

Only telegraph and telephone matters now remain for notice. The Post-Office and the National Telephone Company have naturally made great progress again, and municipal telephony may be called a thing of the past. The government voted about $30,000,000 for further telephone work under the Post-Office during the next few years, and as the transfer date (1911) is approaching, a wise agreement has been made between the company and the Post-Office simplifying the transfer process and avoiding the duplication of plant. The London area is now divided up between the two authorities and each section will be exclusively developed by one or the other. The introduction of the measured-rate system of charging has excited considerable opposition in some parts of the country from larger users. The Post-Office came into a mild sort of collision with trolley tramway authorities when it proposed to utilize the tramway poles for the support of telegraph and telephone wires.

Of wireless telegraphy much might be said, but it is not necessary. The transatlantic developments of the Marconi company are too recent to need more than passing mention. The controversy concerning the British attitude at the radiotelegraph convention was an event of the year. The doings of the Post-Office in wireless work, if fully told by one who

knows, would make good reading. Two things may be just touched here. Early in the year the English de Forest company completed for the Post-Office a radiotelegraph installation for signaling across the Wash (sixteen miles). Important high-speed wireless achievements were recorded also by the Post-Office Department in some preliminary experiments between places fifteen miles distant. Promising results were obtained indicating that Wheatstone working is a practical possibility. The received oscillations actuated a wireless receiver, which in turn acted on a siphon recorder causing the Morse signals to be written in a continuous wavy line. Signals at seventy words per minute were plainly readable.

From the foregoing summary it will be evident that while there has been a dropping away in certain lines of electrical engineering industry, there have been interesting developments and acceptable progress in directions where previously advance had not been so noticeable.

Metallic-Filament Lamps.

A vigorous dissent is expressed here by A. H. Shaw from the opinions of the lamp manufacturer, which were abstracted in the ELECTRICAL REVIEW for December 28, on the effect which the new high-efficiency incandescent lamps will have upon the central station load. Mr. Shaw does not believe that an eight-candle-power, eight-watt, high-voltage lamp will be produced shortly, nor does he think that such lamps would be very popular. His experience at Ilford, England, has been that users of electric lamps have a tendency to go in the other direction, and they are now substituting twenty-five and thirty-two candle-power lamps, and he thinks that the standard lamp of the future will be nearer the former figure. What is required is a twenty-five-candle-power high-voltage lamp supplied at a low price. He sees no reason for anxiety on the part of the central stations in respect to the high-efficiency lamps. At Ilford a good many private users are putting in the new lamps, although the supply is at 230 volts, and it thus becomes necessary for them to burn two lamps in series. This company has also had very good success with supplying small consumers through slot meters. In turn he says that the carbon lamp of the present day is not as good as that made five years ago, and he calls upon the lamp makers to improve the old style of lamp.—*Electrical Engineer* (*London*), *December* 13.

An Important Damages Decision.

Considerable interest attaches to the decision by Judge D. P. Dyer, of the United States District Court for the Eastern District of Missouri, on December 24, entirely setting aside an award of $132,433.35 returned to the Westinghouse Electric and Manufacturing Company by the Master in an accounting running on for several years. The decision is important from the fact that it takes into absolute reckoning the separate value, if any, which a partial infringement may bear to the whole apparatus in which the alleged infringement occurs.

The suit was brought May 10, 1900, against the Union Carbide Company, Niagara Falls, N. Y., under Westinghouse patent No. 366,362. The apparatus involved consisted of certain transformers supplied the Union Carbide Company by the Wagner Electric Manufacturing Company, which assumed the defense of that suit. All the claims of the patent, five in number, were involved.

The same suit also involved E. Thomson patent No. 430,328. This litigation went through the United States District Court for the Western District of New York, and finally to the United States Court of Appeals in New York city. The Wagner company won on the Thomson patent No. 430,328, and during the progress of the litigation four of the five claims of the Westinghouse patent were withdrawn from the litigation, the Court sustaining claim four of the Westinghouse patent. Prior to the Court of Appeals' decision in this litigation the Wagner company discontinued the use of details of construction covered in claim four of this patent. Following the decision of the Court of Appeals an injunction was applied for in St. Louis against the Wagner company direct, and as it had discontinued the construction, it consented to the injunction without a contest.

Some months later contempt proceeding were brought against the Wagner company in the United States District Court of St. Louis, claiming that the modified construction employed by the Wagner company in its transformers still infringed claim four. These contempt proceedings resulted favorably to the Wagner company, a further injunction on the new construction of the Wagner company being denied. The case was continued to a final hearing, to establish by further suit that the new construction of the Wagner company was still covered by the Westinghouse patent. This was disposed of by Judge Adams, of the United States District Court, who held that the new Wagner construction was not in any sense covered by claim four, but in this litigation before Judge Adams the injunction was continued as against the earlier construction on which the Union Carbide case had been decided, and in the usual way the Court ordered an accounting as to damages growing out of the earlier litigation. In this accounting the Master, Judge Dennison, reported in August last, the award of damages amounting to $132,433.35.

To this report of the Master the Wagner company took exception, and those exceptions are now sustained by Judge Dyer, holding that the damages sustained were nominal only, and assessing $1 against the Wagner company.

Memorial Services in Honor of Lord Kelvin.

A memorial service in honor of the late Lord Kelvin will be held under the auspices of the American Institute of Electrical Engineers, in the auditorium of the Engineering Societies Building, 33 West Thirty-ninth street, New York city, on Sunday, January 12, at 3.30 o'clock. All the national learned societies have been invited to participate in these exercises, and among those who will make memorial addresses are: Henry G. Stott, president of the American Institute of Electrical Engineers; Elihu Thomson, past-president of the American Institute of Electrical Engineers; Edward L. Nichols, president of the American Association for the Advancement of Science; George G. Ward, local honorary secretary, Institution of Electrical Engineers; George W. Melville, rear-admiral (retired), United States Navy; T. Commerford Martin, past-president of the American Institute of Electrical Engineers. Ladies are cordially invited.

Annual Meeting of the Northwestern Electrical Association.

The following papers will be presented at the annual meeting of the Northwestern Electrical Association on January 15 and 16, to be held in the clubroom of the Hotel Pfister, Milwaukee, Wis.:

"Debt of the Public to the Public Service Corporation," by W. R. Putnam, of the Red Wing Gas, Light and Power Company, Red Wing, Minn.

"Steam Notes on Small Turbine Plants," by Mr. Hetch, mechanical engineer, North Shore Electric Company, Evanston, Ill.

"Depreciation," by C. N. Duffy, Milwaukee Electric Railway and Light Company.

"Electrical Notes on Small Steam Turbine Plants," by Mr. Pendell, mechanical engineer, North Shore Electric Company.

"Electric Lighting in Cities and Villages of 3,000 People and Under," by Irving P. Lord, Waupaca, Wis.

"Wisconsin Utility Law."

THE RELUCTANCE OF THE AIR-GAP IN DYNAMO MACHINES.[1]

BY THOS. F. WALL.

(Concluded.)

APPLICATION OF THE EXPERIMENTAL RESULTS.

The results of the foregoing experiments may be used to find the effect of slotting the armature on the reluctance of the air-gap. It is necessary to know this in order to calculate the ampere-turns, and there are two methods of considering the matter.

First, when the armature is slotted the number of ampere-turns necessary to send the flux through the gap is determined by the maximum flux density under the teeth; the average flux density, however, is smaller than this maximum value, and the ratio of the maximum density to the mean density is the ratio of the number of ampere-turns necessary to send a given flux through the air-gap with a slotted armature, to the number of ampere-turns necessary to send the same flux through the same air-gap with a smooth armature. This ratio is a factor which Arnold calls k, and is a kind of contraction coefficient which enables the necessary ampere-turns to be at once calculated. For a smooth armature k_1 is, of course, equal to 1, and for all other cases is greater than 1.

Arnold[2] has given a curve showing how to find the value of this coefficient for all practical values of slot, gap, and tooth width. The factor k_1 is given as equal to $\frac{t_1}{z_1 + X\,\delta}$ where t_1 is the slot-pitch; z_1 is the tooth width at the circumference of the armature; X is a factor dependent on the ratio $\frac{\text{slot}}{\text{gap}}$, and δ i the length of the air-gap. The factor X was determined by drawing the lines of force between the armature teeth and pole surfaces for various proportions of slot, gap, and tooth width. The lines of force are drawn by trial so that the total flux as measured from the drawing has a maximum value. By this means a curve was obtained showing the relationship of X to $\frac{\text{slot}}{\text{gap}}$. This curve is reproduced in Fig. 14.

From the experimental results given in the first part of this paper it is easy to deduce the values of X for different values of the ratio $\frac{\text{slot}}{\text{gap}}$, for k_1 can be obtained from the figures already given. Thus $k_1 = \frac{\text{maximum flux density of air-gap}}{\text{mean flux density in air-gap}}$. It must be remembered that the maximum flux density in the air-gap is to be taken as the mean of the flux density at the middle of the surface of a tooth and the maximum flux density at the surface of the armature just opposite. For, as was pointed out above, the flux density at the middle of the tooth face is, in general, higher than at a point on the pole surface just opposite, especially if the gap is large compared with the slot width. All the factors, except X, in the expression $k_1 = \frac{t_1}{z_1 + X\,\delta}$ are thus known.

In the following table the values of the ratio of slot to gap and the values of k_1 obtained from the curves are given. In the third column the corresponding values deduced for X are to be found.

TABLE.[1]

Ratio $\frac{\text{Slot}}{\text{Gap}}$	k_1.	X	
1.99	1.15	1.49	From Figs. 10 and 11.
2.05	1.18	1.42	
2.05	1.15	1.51	
2.05	1.11	1.59	
2.83	1.26	1.88	From Figs. 12 and 13.
2.93	1.26	1.88	
2.77	1.23	1.69	
2.83	1.22	1.60	
2.92	1.31	1.79	From Figs. 8 and 9.
2.83	1.28	1.61	
2.83	1.25	1.60	
2 89	1.24	1.59	
6.73	1.55	2.81	From Figs. 6 and 7.
6.10	1.37	2.70	
6.30	1.40	2.90	
6.70	1.35	2.78	

[1] In this table the "equivalent" slots have been used to find the ratio $\frac{\text{slot}}{\text{gap}}$, *i. e.*, the slot width has been taken as equal to the distance between the minimum ordinates in the curves of flux distribution on the smooth face of the pole-piece.

Thus each of the Figs. 6, 7, 8, 9, 10, 11, 12, 13 give a set of values for $\frac{\text{slot}}{\text{gap}}$ and X, and the means of the values for each set have been plotted as the full line curve in Fig. 14, the ratio $\frac{\text{slot}}{\text{gap}}$ being denoted by V. It is seen from this curve and the corresponding curve for the values as deduced from pictures of the lines of force that the experiments give slightly higher values for X than the graphical method; that is, the experimental values of k_1 are less, and therefore the reluctance of the air-gap is less.

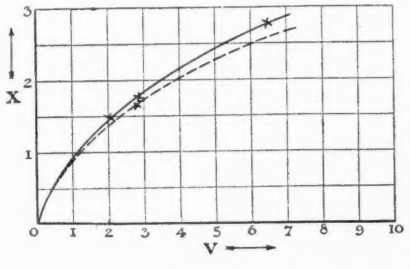


FIG. 14.

The full-line curve shows the values obtained experimentally. The dotted curve shows the values as given by Arnold.

Another method of taking account of the presence of slots in the armature and their effect on the reluctance of the air-gap is as follows: The total flux issuing from a tooth being known, the effective width of the tooth is taken as that width which would give the same flux if the density were constant and equal to the maximum density actually existent under a tooth, and the width of the pole is taken as equal to the number of teeth under the pole multiplied by the effective width of a tooth as given above.

The amount of fringing from the flanks of the teeth as dependent on the proportions of slot, tooth and gap was given by Carter as a coefficient.

From the formula given by him a curve has been deduced showing how the amount, which must be added to the actual width of the tooth in order to get the ideal width, may be found for any practical value of the ratio of $\frac{\text{slot}}{\text{gap}}$.

From the experimental results this effective width is found as follows: Amount by which the actual width of the tooth is to be increased $= \frac{\text{area of flux curve}}{\text{maximum ordinate}}$ minus the tooth width, and $\Delta = \frac{\text{amount added}}{\text{slot}}$.

In this way the values of Δ have been deduced for the various ratios of $\frac{\text{slot}}{\text{gap}}$.

Thus—

Slot Gap	Δ (Experiment.)	Δ (Carter.)
2.85	0.574	0.640
2.84	0.620	0.640
2.03	0.730	0.712
6.45	0.458	0.485
0.0	.....	1.000

APPLICATION TO INDUCTION MOTORS.

When both the stator and rotor are slotted, as in an induction motor, the flux distribution curve for the air-gap becomes very complex, and, moreover, changes its shape as we proceed from the stator surface across the gap to the rotor surface. Further, the curve of flux distribution on the stator periphery has a period of pulsation corresponding to the movement of the rotor over a distance equal to the pitch of the rotor teeth, and the curve of flux distribution on the rotor periphery has a period of pulsation corresponding to the movement of the rotor over a distance equal to the pitch of the stator teeth.

In order to draw the flux distribution curve on the periphery of either the stator

[1] A paper read before the Manchester section of the Institution of Electrical Engineers of Great Britain, December, 1907.

[2] *Die Gleichstrommaschine*, vol. i, p. 271.

or the rotor the following may be considered:

Suppose it is desired to find the flux distribution over the periphery of the stator. First imagine that the stator has a smooth surface; we can then draw the flux distribution curve on the surface due to the slotted rotor (Curve I, Fig. 15). The method of drawing curves of flux distribution has been already indicated, and an examination of the various curves given will be of assistance as a general guide as to the shape of the curves for any given proportions of slots, teeth and gap. After a little practice these curves of flux distribution can be drawn with considerable rapidity. Next suppose that the rotor has a smooth surface and the stator is slotted; we can then draw the flux distribution curve on the surface of the stator teeth

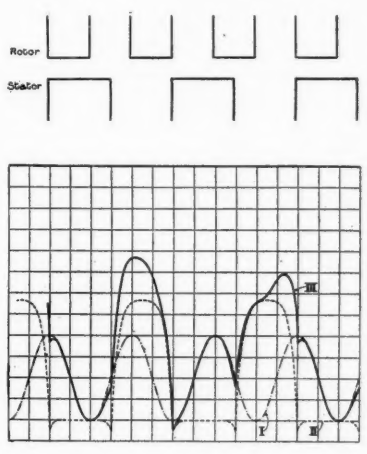


FIG. 15.—SHOWING FLUX DISTRIBUTION AT THE PERIPHERY OF THE STATOR.

from the results of the experiments previously described. This curve is shown in Fig. 15 as Curve II. Now take the actual case in which both the stator and rotor are slotted, then the actual curve of flux distribution on the stator surface will be found from a combination of the two curves. Thus in Fig. 15 the ordinates of Curve I are to be reduced in the ratio of the corresponding ordinate of Curve II to the value the flux density would have if both stator and rotor were smooth. In this manner the resultant Curve III has been deduced from Curves I and II, *i. e.*, the ordinates of Curve III are equal to the corresponding ordinates of Curve I multiplied by the ratio of the corresponding ordinates of Curve II to the height of the horizontal line, which gives the constant density which would exist in the air-gap if both stator and rotor had smooth cores. This horizontal line touches the peaks of Curve I.

Curve III only holds for the relative position of stator and rotor teeth shown, and the curve will vary in shape as the rotor surface moves through a distance equal to the pitch of the stator teeth.

The corresponding curve for the flux distribution over the periphery of the rotor may be found in a similar way. It has been assumed in the above that the magneto-motive force is constant at all points of the air-gap. For any given curve of magneto-motive force a simple modification must be introduced.

In order to find the reluctance of the air-gap in induction motors, we may say that if the reluctance is unity when the rotor and stator surfaces are smooth, suppose k_1 is the coefficient when the rotor alone has slots, *i. e.*, the reluctance of the gap with slotted rotor and smooth stator is k_1. Suppose further the gap coefficient to be k_2 when the stator is slotted and the rotor has a smooth surface. Then the reluctance of the gap when the stator and rotor are both slotted will be given without any great error by the product k_1-k_2. Now k_1 and k_2 can be found by the method previously described, from the dimensions of the teeth, slots and air-gap, and therefore the reluctance of the gap can be at once determined.

In conclusion, the author would like to express his appreciation of the facilities placed at his disposal for this work by Professor E. Arnold; for the valuable advice given and the interest shown in the experiments by Professor Bragstad, and further to acknowledge Dr. Kloss's kindness in critically reading the paper through.

The Tungsten Electric Lamp Company.

Situated in Cleveland, Ohio, there is a fireproof building made up of four stories and a basement. It is fifty-five feet by 112 feet, and has a floor area of over 30,000 square feet. This stands as an example of the faith of sixteen prominent lamp manufacturers in the future of the tungsten lamp. For it is in this building that the most modern incandescent electric illuminant is being produced. The entire establishment is occupied by the Tungsten Electric Lamp Company, which was incorporated under the laws of the state of Ohio on October 29, 1907, with a capital of $100,000. The incorporators are: G. G. Lockwood, A. C. Garrison, H. B. Vanzwoll, A. S. Terry, H. H. Geary, L. P. Sawyer, J. C. Fish, H. C. Rice, E. H. Haughton, E. W. Gillmer, J. B. Estabrook, W. D. Packard, William Coale, E. J. Kulas, J. E. Randall and T. W. Frech, Jr.

Mr. Frech is president and manager, and Mr. Randall is vice-president and supervising engineer. These two gentlemen are among the most experienced in the lamp business. The former, in days gone by, worked up through the ranks to the position of superintendent and then manager of a carbon-lamp factory. Mr. Randall has given his attention more to the technical end. As far back as 1886 he was lamp engineer for the Thomson-Houston Company. It would be hard to find two more competent men for the guiding of this new enterprise—one thoroughly versed in the manufacturing end and the other possessed of every detail of the technical side.

Messrs. Frech and Randall have spent many months in other countries studying the laboratory work being done on tungsten lamps and investigating factory methods in foreign countries. After several trips abroad, much experimenting at home, and many discussions with their lamp brothers, who were to become interested in the Tungsten company, they finally reached the point where they believe the tungsten lamp to be ready in every respect for the commercial market.

The lamps are now manufactured in forty and sixty-watt multiple, and 4, 5.5, 6.6 and 7.5 ampere street series, with a range of forty, fifty and seventy-five-watt sizes. The average rating of these lamps is 1.25 watts per candle.

The chief advantages of the tungsten lamp are its high efficiency, the current consumption of a regular carbon-filament lamp of equal candle-power being two and one-half to three times greater, and the fine quality of light which it furnishes. Under the rays of the tungsten lamp colors retain their true daylight values.

Pictures by Wireless.

Nevil Maskelyne, manager of the Anglo-American Telegraph Company, which controls the Poulsen wireless rights, is quoted in London (England) papers as follows: "The new year will not only see the establishment of the Poulsen wireless telephonic service across the Atlantic, but also the establishment of the Poulsen wireless transatlantic service whereby photographs and sketches illustrating European news for American newspapers and photographs of criminals with such fidelity that they can be readily identified will be flashed across the Atlantic at the rate of one every five minutes."

A Remarkable Dynamometer.

On the afternoon of Monday, January 6, an exhibition test of a remarkable dynamometer was made at the clubhouse of the Automobile Club of America, New York city. This unique machine will determine instantly the speed in miles per hour, the feet per second, the drawbar pull or tractive effort, the horse-power, the grade-climbing ability and the power of the brakes of any automobile which is placed upon it. This machine is of great importance to owners and purchasers of cars, and will certainly be welcome among manufacturers, because it will enable them to determine precisely what their cars can do, and will give them a standard to which they can refer with confidence. There is no other machine in the world which will do the work of this one, and possibly no other institution could afford to construct and put into operation a similar machine. The dynamometer, besides being the most complete apparatus ever built for testing automobiles, makes it unnecessary to hold speed tests upon the open road, eliminating all danger of road accidents and giving results quickly and accurately.

The accompanying illustrations will give some idea of the magnitude and significance of the apparatus. While, at first sight, it may appear complex, the interrelations have been so carefully worked out and the translating and magnifying apparatus so ingeniously connected, that very early in the test even the layman with very little technical knowledge can readily understand the functions of the apparatus and appreciate the indications secured.

The club dynamometer has a moving track upon which cars can be fully tried while remaining stationary and under observation. In 1904 Dr. Schuyler Skaats Wheeler, first vice-president of the Automobile Club of America, was requested by the club to invent, design and build a machine for determining the performance of cars of all kinds. The present machine is therefore the result of several years' attention to the problem on the part of Dr. Wheeler. It is an assemblage of power-absorbing and measuring instruments and a large power chart with automatically operated pointers. It carries the problem of power measurement, integration and automatic recording of the final results much further than has hitherto been attempted. It absorbs and measures the power so that, at a glance, the speed, tractive effort and horse-power can be clearly seen and read at each instant. The measurements show the power delivered at the ground by the wheels of the automobile. This includes every element in the operation of the automobile, and therefore shows the net power that is available for driving the car.

Instead of traveling along as on a road, the car is held stationary by cables upon the floor, with its driving wheels resting upon two large drums which reach up through the floor, and which the motor of the automobile causes to revolve. Fig. 1 is a general view of the indicating and translating apparatus, and Fig. 3 a nearer view of the chart, the traction indicator, the timing motor and the speed indicator.

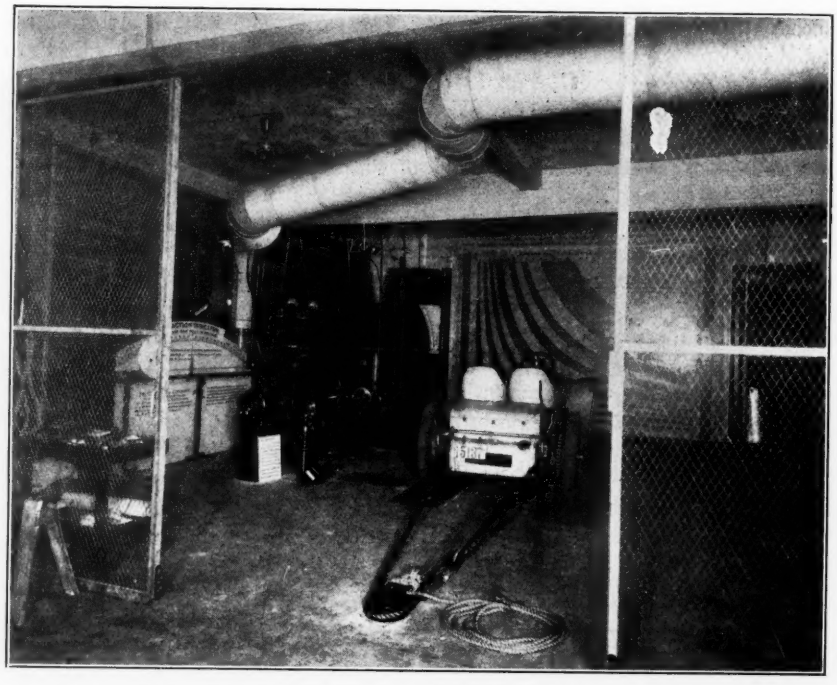


FIG. 1.—AUTOMOBILE IN POSITION FOR TRACTIVE EFFORT AND SPEED TEST.

Fig. 2 shows the view on the floor below and indicates clearly the relations of the revolving drums and the auxiliary apparatus. Just to the left of one of the revolving drums is a clutch which connects the shaft upon which the drums are keyed to an Alden dynamometer. This form of viscosity dynamometer is well

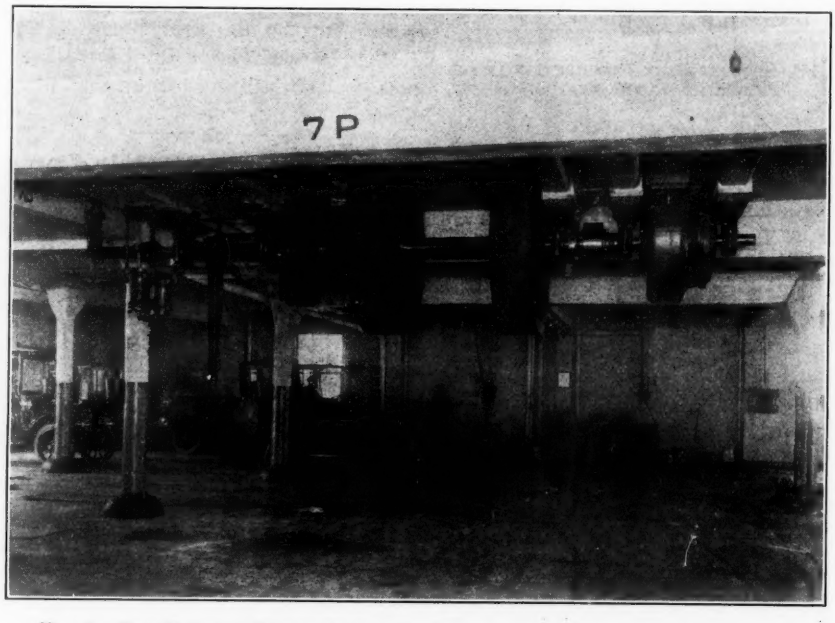


FIG. 2.—THE FRICTION ROLLS, DYNAMOMETER, COUNTERWEIGHT AND AUXILIARIES.

known. Keyed to the same shaft is a 1,600-pound pendulum which resists the effort of the drum shaft and registers the amount of pull effected by the motor of the automobile. The deflections of the pendulum are followed and the pendulum kept from oscillating by means of an oil dash-pot just to the left of the pendulum shaft. On the extreme right of the drum shaft is another coupling which connects in an electrical machine that may be used either as a motor or as a generator for driving the drums or for absorbing power, according to the test under way. Connected directly to the end of the pendulum is a pointer which indicates upon a proper scale the drawbar pull in pounds. This pointer, in its oscillation across the scale, makes contact with an arm on a traveling carriage, which causes contact to be made to either one or the other side of an electrical circuit connected with a traction follower motor. This traction follower motor causes the carriage to be pulled one way or the other, and by means of steel cords the motion is translated to a ruler which forms the vertical bisector on the heroic chart shown in the background of Fig. 3.

For measuring the speed of the car a complicated and ingenious apparatus is made use of. This is shown directly by means of a horizontal ruler traveling up and down the face of the chart.

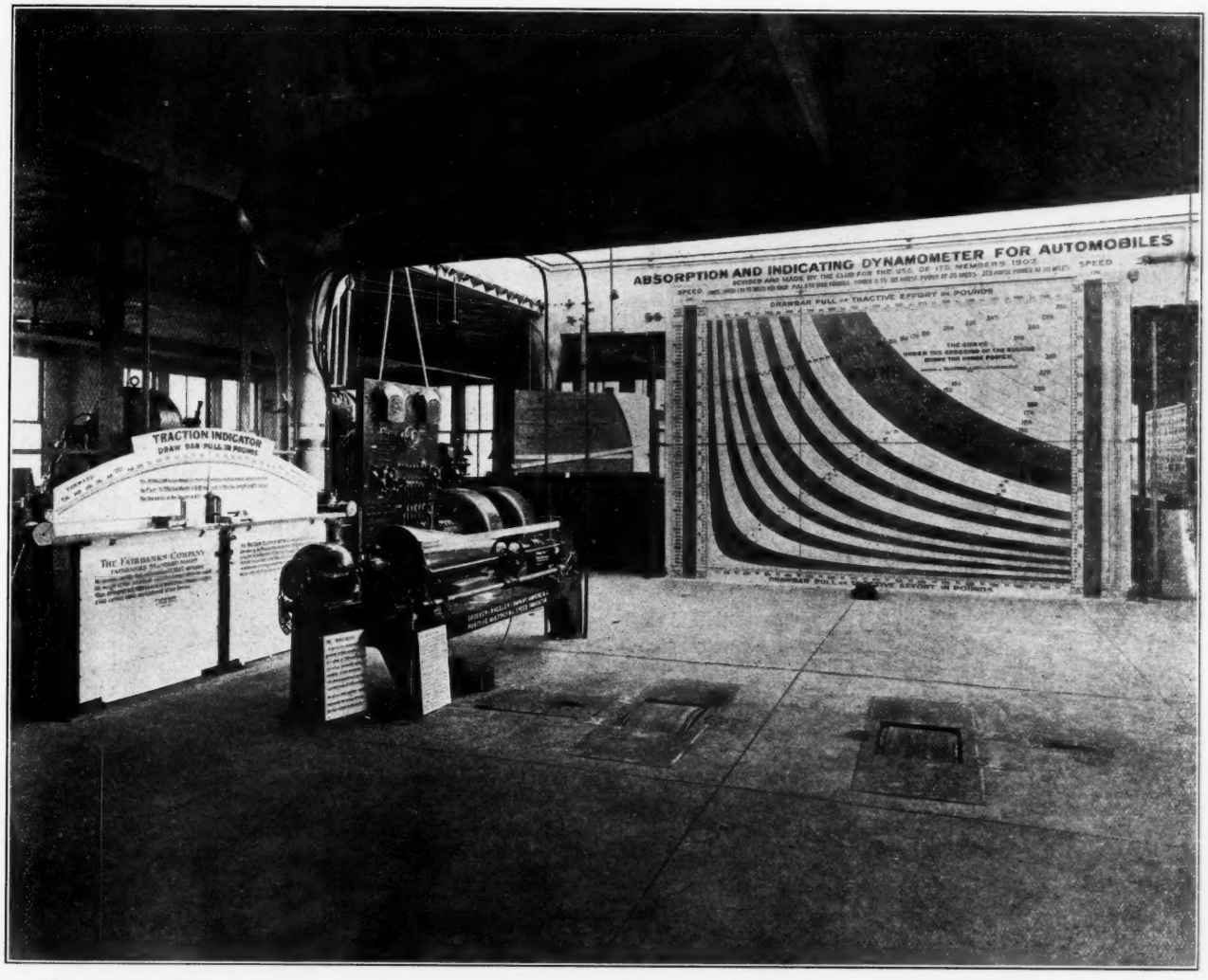

ABSORPTION AND INDICATING DYNAMOMETER FOR AUTOMOBILES
TRACTION INDICATOR
DRAW BAR PULL IN POUNDS
THE FAIRBANKS COMPANY

FIG. 3.—A GENERAL VIEW OF THE ABSORPTION AND INDICATING DYNAMOMETER, DESIGNED BY DR. SCHUYLER SKAATS WHEELER FOR THE AUTOMOBILE CLUB OF AMERICA.

Referring again to Fig. 2, just to the left of the absorption dynamometer, is seen the beveled-gear connection of a transmission shaft, which is connected directly to the beveled gears operating a shaft upon which a speed roller is mounted. This apparatus is shown in the foreground of Fig. 3. The timing motor drives a cone at a constant speed of 300 revolutions per minute. To verify this speed, a bell attached to the cone shaft rings at each 100 revolutions or at intervals of thirty seconds. The speed roller driven by the automobile, and therefore revolving slowly or swiftly, to correspond, rolls upon the surface of the cone and is pulled by a speed follower motor back and forth between the large and small ends of the cone until it finds the point where it does not slip, because that portion of the cone presents the same speed as the roller. This longitudinal adjustment of the roller is transmitted by a wire cable to the speed ruler on the chart, and the power required for moving the ruler is thus made independent of the automobile: in other words, none of the power of the automobile is used in operating the indicators on the chart. The method of speed measurement employed, based upon one element running at a constant speed, like a clock, that can be verified, insures great accuracy. The roller driven by the car, if running at sixty miles per hour, must be drawn to a position near

the large end of the cone in order to run with the cone; whereas, if the car drives the roller at only five miles per hour, it must be drawn to a position near the small end of the cone. A system of electric contacts is arranged in connection with the speed follower motor to shift the roller automatically until it finds the point where it will roll on the cone without slipping. The speed and power rulers are thus moved across the chart automatically to correspond with the speed and the tractive effort or pull that the dynamometer shows the car is making.

In Fig. 3 a clear idea is given of the chart, which shows the horse-power corresponding to each different speed and pull, so that the result at each moment can be read at a glance and without calculations. The readings on the chart may be made in miles per hour, minutes per mile, kilometres per hour, etc.

All of the measuring apparatus is made reversible so that, when running backward, the performance of the car may be measured. As a secondary apparatus, a grade meter is provided, operated by the pendulum indicator of the dynamometer. To use the grade meter a clamp is set upon a sliding scale at the point representing the weight of the car. The moving lever then assumes at each moment the angle of inclination of the grade the car would climb (if there were no wind resistance, slipping, etc.) with the effort that the car is then making. The grade meter is shown in the background just to the left of the chart.

To observe an automobile coasting down hill, either forward or backward, it is necessary merely to start the electric motor on the shaft carrying the two large drums upon which the driving wheels of the automobile rest. The brakes may then be tested and the wheels or gear or engine may be run free, and the relative friction loss in the principal of the automobile may be ascertained.

The apparatus has been constructed by the Crocker-Wheeler Company, Ampere, N. J. The traction follower motor and the speed follower motor are special machines, and the timing motor is a standard Crocker-Wheeler motor. The cone is kept at a constant speed by means of a special design of centrifugal governor. The equipment includes a generator for supplying current to the traction follower motor and the speed follower motor, and a motor-generator set for supplying power to the motor operating the driving rolls or absorbing power from them. A substantial switchboard has also been installed, controlling the main circuits, and equipped with special double-throw switches which are connected according to the conditions of the test. A Weston direct-reading voltmeter and ammeter are used for taking the ampere and volt readings when the automobile is absorbing power, or for making the coasting and running-away tests. The balance weight has been certified by the Fairbanks Company. An induced draft and suction carries off the exhaust from the automobile under test.

The Green Quartz-Alumina Insulation.

A new form of insulation which possesses a number of features of great importance to the electrical industry has been developed, the aim having been to get an absolutely non-carbonizing, non-deteriorating insulation which would be of the greatest utility as an insulator worked up into any form and used in any application. The base of the insulation is asbestos from which the magnesia and iron have been eliminated, leaving in its first reaction an unbalanced product. To take the place of the magnesia and iron removed, the inventor adds a material which makes the insulation practically fibrous quartz-alumina.

The makers have completed arrangements to vulcanize this insulation in various forms containing eighty-two per cent of quartz-alumina and eighteen per cent of rubber composition. This will be used for all sorts of insulating pieces, such as bushings, cleats, receptacles, outlets, etc. Arrangements are also being made to manufacture an electrical porcelain containing seventy-five to eighty per cent of quartz-alumina, and plans are under way to insulate wire with this material.

Tests recently made of insulating paper manufactured by the Green Insulation Company showed a dielectric strength of 175 volts per mil over a thickness of 10.8 mils of paper with the paper in normal condition. With the paper baked there was a fall of potential of 182 volts per mil with the same thickness of paper. With the paper burned there was a fall of 183 volts per mil, and with the paper wet the drop of potential was 99 volts per mil.

The insulating paper is made with a centre of the best Manila obtainable, and the quartz-alumina composition coated on each side.

The company, which is located at Cleveland, Ohio, claims that with this insulation it is able to very largely increase the current-carrying capacity of a given conductor, by reason of the insulation being able to withstand intense heat and also by reason of its facility for dissipating the heat occasioned by the rise in temperature.

FENCE POSTS MADE DURABLE.

WOODS GIVEN SIXTEEN YEARS' ADDITIONAL SERVICE BY PRESERVATIVE TREATMENT.

Fence posts of many kinds of cheap woods which ordinarily would soon decay if set in the ground can be made to last for twenty years by a simple treatment with creosote. Most of the so-called "inferior" woods are well adapted to the treatment, and this is especially true of cottonwood, aspen, willow, sycamore, low-grade pines and some of the gums. When properly treated, these woods outlast untreated cedar and oak, which are becoming too scarce and too much in demand for other uses to allow of their meeting the demand for fence posts.

Impregnation with creosote has been greatly cheapened by the introduction of the "open tank," which can be installed at a cost of from $30 to $45, or much less if an old boiler is used. A tank with a bottom twelve square feet in area will suffice for treating forty or fifty six-inch posts a day, or double this number when two runs a day can be made. The absorption of creosote per post is about as follows: Eucalyptus, one-tenth gallon; willow, two-tenths gallon; sassafras, ash, hickory, red oak, water oak, elm and maple, four-tenths gallon; Douglas fir, quaking aspen and black walnut, six-tenths gallon; sycamore, cottonwood and lodgepole pine, seven-tenths gallon. The price of creosote is about ten cents a gallon in the East and Middle West, sixteen cents a gallon on the Pacific coast and twenty-seven cents per gallon in the Rocky Mountain states. The cost of treating a post will therefore vary from four to fifteen cents. Properly treated, it should give service for at least twenty years.

Experiments of the Forest Service show that with preservative treatment the durability of lodgepole pine in Idaho is increased sixteen years. The cost of creosote is there relatively high, yet by treating posts there is a saving, with interest at six per cent, of two cents per post yearly. More important than the saving, however, is the fact that through preservative treatment other woods are fitted to take the place of cedar, of which the supply is rapidly becoming exhausted. A detailed description of experiments in preserving fence posts, together with practical suggestions for treating them on a commercial scale, are contained in Circular 117 of the Forest Service. This publication can be obtained upon application to the Forester at Washington.

THE COMMERCIAL ASPECT OF ELECTRIC POWER SUPPLY.[1]

BY W. B. WOODHOUSE.

The growth of the demand for electricity for power purposes has led to the adoption of larger generating units, which has facilitated distribution over a larger area at high pressure, and the economy of the large generating station—and inferentially the uneconomy of small stations—is now an accepted fact.

The commercial limitations to the size of a generating station which underlie the whole financial problem of power supply may be briefly summarized as follows:

The argument for centralization is: (1) Reduced capital expenditure per kilowatt of generating plant due to increased size of units; (2) increased efficiency of plant; (3) improved load-factor due to diversity of requirements and demand; (4) reduced wages and management charges; (5) small proportion of stand-by plant.

Against which must be set the disadvantages of: (1) extra capital expenditure on transmission; (2) losses in transmission and conversion.

Practice has shown that the small generating station can not produce electricity at a price sufficiently low to enable it to be supplied to power users at a competitive price. A station of 1,000 kilowatts, for example, can not hope to supply a power user requiring 300 kilowatts as cheaply as the power user can generate for himself; this for several reasons. First, the capital cost of the generating plant in both cases will be practically the same per kilowatt, while the public supply is burdened with an additional cost for mains; secondly, the owner of an isolated power plant will usually install a smaller proportion of stand-by machinery, setting the increased risk of shut-down against the reduced capital charges; thirdly, the public supply station must run continuously, often at very inefficient loads, whereas the isolated plant—a mill engine, for instance—is only run during certain definite hours, so that the "working-load factor" is greater and the works costs less in case of the latter. Apart from this, one finds that the owners of isolated power plants very frequently do not include any allowance for rent, management charges, etc., in estimating their power costs, so that the difficulty of the supply authority obtaining such a load is increased by the power user's want of appreciation of all the items making up power costs. Assuming the power user's load-factor to be equal to that of the supply station, the author's experience is that the limiting size of a consumer's installation, which can profitably be supplied from the central station, is from one-tenth to one-fifth the capacity of the station plant.

As, however, the size of the generating station is increased, the advantages of centralization come into fuller play, although to some extent counterbalanced by the increased capital expenditure on distribution and by the increased losses. These disadvantages of centralization depend on local conditions, such as the density of the power load per mile of main, and on the nature of the load supplied. In any particular case a balance will occur at some point—that is to say, there is a limit to the economical radius of distribution, and, therefore, to the size of the generating station required. It does not appear that there is any limit to the size of the generating station on the score of efficiency and cost per kilowatt.

To take round figures, the capital cost of generating stations of various sizes is as given in Table I:

TABLE I.

Capacity of Station.	Cost per Kilowatt.	Relative Cost Per Cent.
60,000 kilowatts	$50	100
6,000 "	75	150
600 "	100	200

The improvement in efficiency due to the use of large units may be seen by considering some typical figures of turbine steam consumption (Table II). To the full-load test figures the author has added an estimate of the average working figures in stations with a load-factor of twenty-five per cent. It will be seen that the coal consumption of the smallest unit is sixty per cent in excess of that of the largest.

TABLE II.

Size of Generating Set.	Test Figures. Full Load Consumption in Pounds Per Kilowatt-Hour.		Working Figures. Estimated Coal Consumption.	Relative Cost Per Cent.
	Water.	Coal.		
3,000	15	1.875	3.125	100
600	20	2.500	4.160	133
300	24	3.000	5.000	160

Distribution over a large area brings with it the supply to power users with diverse requirements—lighting, traction, general power users and collieries, for example, each has different hours of use, and in each case the peak load occurs at a different hour in the day.

Experience shows that the station demand will not exceed one-third of the total lighting connected to the system, nor one-half of the power installed by power users, and that if the individual maximum demands of a number of power users be added together that figure will be from fifty to 100 per cent in excess of the demand at the generating station, with a consequent improvement of the load-factor.

As to the saving in wages and management charges in the larger station, this depends on so many variables that general figures are not of great value. Since, however, one man can attend to a 3,000-kilowatt set as well as he can to a 300-kilowatt set the saving is obviously considerable. The effect of load-factor on works costs is still more important. Table III is a statement drawn from the author's experience of the effect of load-factor on works costs.

TABLE III.

Items of Cost.	Load-Factor. 15 Per Cent.	30 Per Cent.	60 Per Cent.
Coal.....	100	70	55.0
Wages....	45	25	12.5
Stores.....	10	8	6.0
Repairs....	50	40	30.0
Total....	205	143	103.5
Relative Cost Per Cent....	198	138	100.0

The capital cost of generating plant per kilowatt installed in the large power scheme may be taken at one-half that of a small power station. The diversity factor will approach two; or, taking the two advantages together, a capital expenditure per kilowatt of demand of one-quarter. The works costs are reduced both on account of increased size of generating sets and improved load-factor, the latter advantage representing a saving of fifty per cent over the works costs of the average power user. The total saving due to centralization may be expressed by a curve which shows that before equality of expenditure on isolated and public supply plants is obtained the expenditure on transmission and distribution may be three times as great as that on the station, and the losses and costs of distribution may be increased by 100 per cent. Naturally these extreme figures are never reached in practice, and, therefore, the margin in

[1] Abstract of a paper read before the Leeds Local Section of the Institution of Electrical Engineers of Great Britain.

favor of the power company is a very considerable one.

The prospect of the generation of electricity on a large scale has led engineers to seek for new sources of fuel, and the generation of power by the utilization of waste heat from blast furnaces, coke ovens and similar thermo-chemical processes now forms a separate study. It may be safely predicted that future developments will consist in the cooperation of electric supply undertakings with processes of manufacture in which fuel or heat is merely one of several products to be dealt with. The conditions of the electricity supply will no longer be the sole factor in determining the situation or magnitude of a generating station, but the economical handling of the other products of manufacture will also have a determining effect upon the decision.

There are a number of collieries in the West Riding where waste heat from coke ovens is available to an amount equivalent to from 1,000 kilowatts to 2,000 kilowatts. To erect at each battery of ovens a generating station with spare plant sufficient to insure a continuous supply in the event of breakdown, and to supply from such a station a fluctuating load such as a general power supply demands, is not an efficient arrangement. The high cost of the small generating units per kilowatt, the cost of management and the partial use made of the plant, all tend to increase the cost of supply. When, however, a number of such stations are worked in conjunction by a power company the amount of spare plant may be reduced to a minimum, and each station would consist of a single generating unit, with no spare plant, running continuously at full load or else shut down completely. The resultant economy of capital expenditure and operating costs of such an arrangement is considerable. This is rather a reversal of the present idea of the peak-load station, the author's view being that the station dealing with fluctuations would contain the biggest and most economical units, and would be the largest station of the system.

The development of electrothermal and chemical processes introduces a class of load of high load-factor, which, added to a general supply, increases the load-factor on the system. But where, as is usual, the demand is a large one the price at which it could be generated in a station designed specially for that purpose is so low that only a large undertaking could offer a supply at a corresponding price. There is, however, a possibility of development in the use of a restricted supply of current varied according to the power station's requirements and designed to equalize the demand on the station. Typical load curves showing the variation of maximum demand on a station throughout a year and for a winter's day of a station supply light and power, show that there is necessarily a considerable amount of generating plant which is lying idle for the greater part of the year, its use being, in fact, only required for a few hours a day in the winter months. If a load can be found which may be varied inversely as the normal demand, then a profit may be earned by such machinery throughout the year. The author has recently arranged an agreement on these lines for the Yorkshire Electric Power Company with a company manufacturing calcium carbide by electric furnaces. The improved conditions under which the station will operate should show a considerable decrease in the average costs of production.

The arrangements mentioned above involve cooperation between those who produce waste heat, the general power user and the power company, and, in fact, the power company may be regarded as a joint committee of such manufacturers. The cooperation of collieries alone through such an agency would effect an enormous annual saving. The output of coal for Yorkshire in 1906 was thirty-three million tons, and assuming, as we fairly may, that five per cent of this was used for power purposes by various collieries, we have an amount of fuel which, if consumed by the power company under their economical conditions of working, would supply not only the collieries, but practically all the textile mills in Yorkshire. The blast furnaces of the kingdom also produce a large amount of waste heat, and a very large portion can be utilized by cooperation with the power companies.

The considerations dealt with above as to the advantages of a public supply to a power user apply with even greater force to small and medium-sized public supply generating stations, say, of less than 10,000 kilowatts.

Of causes other than the direct advantages of power supply, which are assisting the development, two may be mentioned. The abolition of the smoke nuisance in towns is receiving increased attention on all sides, and there are undoubtedly signs of decrease of the nuisance in towns due to the use of electric motors and gas stoves, as well as to the more stringent action taken by some local authorities. Doubtless the improvement in the atmosphere of districts where the electric supply is generally adopted will become so noticeable in a few years that other districts will be forced to take action. It is obvious, however, that strong action can not be taken fairly by the local authority unless a cheap power supply is available in its district, and it must first see that such a supply is provided. But a more important reason for the action of local authorities in the matter of a cheap power supply is the steady industrial exodus that is going on from all the large towns. High taxes, crowded sites and dear power all act as an incitement to a manufacturer to remove to a cleaner and better place. The facilities for transit of men and material have so increased of late years that with the aid of electric power wo do seem to be approaching the ideal of industrial decentralization, if not a return to cottage industries. The ultimate effect of this decentralization on the finances of large towns is a matter worthy of the most serious consideration.

The sale of electricity can be developed by a well-organized system such as one applies to the sale of any other commodity, but it can only be carried out successfully by a careful study of the requirements of the various power users, and therefore by a staff of commercial engineers. The fact has been impressed on the industry lately by the technical press, and with considerable justice, that the selling organization of most supply undertakings has been somewhat neglected. Here, again, is room and a necessity for cooperation among the various supply authorities. Anyone who, like the author, has had to do pioneer work in the electrification for the first time of an industry such as the textile, realizes how valuable may be an accumulation of data relating to the power taken by various machines, the unit consumption, the load-factor, etc. If every undertaking were working together, such information could be collected by a central bureau and would be available to all. This refers not merely to technical data, but also to such points as legislative restriction and government regulations.

Of much greater value would be a central advertising association. One is only too apt to assume that the general public are familiar with all the advantages and developments of the use of electric power. It may be safely said that the general public, except perhaps as regards electric tramways, is more ignorant of the extent of electrical development than of any other industry of similar importance. This can only be removed by systematic advertising and circulation of information, and this, again, can only be properly carried out by a combination of supply authorities each contributing to a common fund for such work.

Electrical Progress in Europe.

By C. L. Durand.

PROGRESS has been very marked during the year in the matter of electric railroads in most of the leading countries. This is especially noted in Switzerland, and one reason for the development of electric railroads in this country lies in the abundant supply of water power which is to be had. The new Lötschberg railroad is one of the most important undertakings, on account of the work upon the tunnel, which passes through the Alps, and is over eight miles in length. It will require about five years to finish the tunnel, and the expense of the enterprise is $16,000,000. Quite recently the National Council decided to construct the second tunnel of the Simplon, as there is now enough traffic on the electric section to warrant the enterprise. In general, the electric line has been working very well during the year, and two new locomotives have been built by the Brown-Boveri Company. One of the large Swiss construction firms, the Alioth Company, has been building a type of electric locomotive which will develop about 2,000 horse-power. It takes single-phase current from a trolley wire, and this is converted to direct current by apparatus mounted on the locomotive. The Jura-Neüchatel Railroad purposes adopting the electric system in the near future, and there is a project on foot for an electric line between Lenk and Adelboden, also a new electric road from Brigue (on the Simplon road) to the Jungfrau, passing up the mountain slope on the rack-rail system. The Swiss Government is looking forward to a complete change-over of all the railroad lines in the country, and the technical commission appointed for the purpose has made a favorable report. For 2,000 miles of railroad there will be 100,000 kilowatts needed.

In France the existing railroad sections are now working well, but there is not much new electric railroad work to report except the subway construction in Paris. This is quite an important piece of work. Tunnels for a number of lines are now being put through, and in one case there is an elaborate metallic caisson construction going on under the Seine. One of the newest lines crosses the Seine in a double metallic tube. This work is now going on by the use of the shield and compressed-air method. The city decided just lately to proceed with several new subway lines, probably seven in number, so that before long Paris will have by far the largest network in Europe. It is proposed to carry out a very extensive project for a subway system in Berlin. Several of the leading electric firms have submitted plans to the municipality for this purpose. Another project which is to be noted is an electric line connecting Berlin with St. Petersburg. Part of it would be carried out by steam ferries and there would be three electric sections in Germany, Sweden and Russia. A newly completed electric line now runs from Münster to Schlucht, in Alsace, and it lies at a high altitude. The three-phase, 7,000-volt Alioth system is used in this case. Following out the ideas of the Italian Government to extend the electric lines, work has commenced on a double-track road between Turin and Bussoleno. The new Locarno-Bignasco electric road will soon be put in service and, as it passes through the picturesque Maggia valley, it will be favored by tourists. A concession has been asked for an electric railroad from Brescia to Caffaro and other sections, having 120 miles total length. The Stockholm-Jarfva electric section in Sweden is the commencement of the government's plan for changing over all the railroads. Locomotives and motor-cars on the three-phase system are now in use here. The state has a project which calls for expending $18,000,000 for hydraulic plants and pole lines in order to have the needed current for the future work.

As regards electric tramways, an important piece of work has been begun upon the transformation of all the traction lines in St. Petersburg, comprising 130 miles length. A large steam plant is building on the Obvodny Canal for this purpose. Upon some of the lines in Vienna the new Krizik system is to be employed, using 3,000 volts direct current upon the motors. The Blankenese-Ohlsdorf line, near Hamburg, is now operating very successfully. A large station is erected for the purpose in which monophase current is produced, while rotary groups give direct current for the trolley wire. Monophase current will be used on the new suburban lines in the district of Parma, Italy, employing 4,000 volts upon the motors outside of the towns and 400 volts inside the limits. The cars have two sixty-horse-power motors and are fitted with Siemens-Schuckert apparatus. A line from Rome to Civita Castellana is now working upon the same system, in which there are 6,000 volts in the suburban part and 600 volts in the city portions. Palermo is soon to have an additional tramway line to the extent of twenty-five miles for the city and suburbs. At Paris there have been installed several new sections of Thomson-Houston underground conduit road. In Switzerland the mountain road which climbs the Rigi has been transformed to the electric system. Japan at present has 130 miles of tramways, which are operated by eighteen companies, and there are eighty miles in construction. The capital employed is stated to be $20,000,000.

In the different regions of the Continent where water power is to be obtained, there is to be noted the construction of a number of hydraulic plants, and there are also many projects for turbine stations which are soon to be realized. Upon the Tronto river, lying in the central region of Italy, is soon to be erected a 20,000-horse-power station which will be used mainly for electrolytic work. It is to be operated on the Lahmeyer three-phase system. In the Apennine region in the northern part of the country the Chiappa plant now uses the water from the two lakes of Lavezze and Lagolungo, and there are four Piccard and Pictet wheels installed here. Thury direct-current generators are employed, upon the constant-current-series system. A distribution network throughout the Brusio region is using a 10,000-horse-power hydraulic plant having six groups of three-phase alternators, and this will be increased to 40,000 horse-power. There is an important power line in the Milan region which is supplied from the Trezzo plant on the Adda stream. When finished it will have ten turbine groups with 10,000 horse-power total. The line works at 14,000 volts, three-phase.

At Engelberg, Switzerland, there is a plant on the Aar river which supplies a power line and also gives current for the Stansstad-Engelberg railroad. It uses three-phase and single-phase machines to the extent of 20,000 horse-power, and will be increased to 30,000 horse-power. The three-phase current is used mainly for motor work. In the Bale Canton there will be erected two 25,000-horse-power plants on the Rhine, and the necessary credits of two millions have been already voted. Part of the current will be used at Bale and the rest upon a set of power lines. The Rhone, near Geneva, is to be

utilized for a second large plant, at La Plaine, using two-phase alternators. An extensive set of power lines, operating at 25,000 volts, will run to Geneva and other centres. Work will soon be commenced on a series of turbine plants upon the Reuss river which are to give a total of 20,000 horse-power.

The new station on the Trolhattan fall, in Sweden, will be one of the largest on the Continent, and is to give 75,000 horse-power. Most of the turbine units will have 10,000-horse-power alternators. From the plant a forty-six mile power line will run to the city of Gothenburg. An electric furnace plant will take also a part of the current. Among other plants in Sweden may be noted the Lagan (9,000 horse-power), the Hemsjo falls (2,400 horse-power) and the Olofstrom (3,000 horse-power). The government has already commenced the purchase of a number of falls in order to secure current for the railroads. A syndicate in Norway has secured a concession from the state for 80,000 horse-power from different falls, and will soon erect four plants costing $2,500,000. It is stated that the Japanese Government intends to erect a number of plants near Tokio to the extent of 100,000 horse-power, costing about $10,000,000.

The use of steam turbines has increased considerably during the year, and they appear to have the preference over reciprocating steam engines in the construction of the new plants. The French Westinghouse Company has now taken up the manufacture of turbines, and one of the recent plants which it installed is located at Bergamo, Italy. The first of these turbines is of the 1,500-kilowatt size, and is coupled to a three-phase alternator. At its Paris factory the Thomson-Houston Company is now building turbines extensively, and has already installed them in Germany and in France. Among the latter plants we may note the large station at Nice, which contains two units of 1,000 horse-power; also the tramway stations of Rheims and Nancy, and the Risso plant in the south coast region. These turbines are of the Curtis type. One of the leading firms to manufacture turbines is the Swiss Brown-Boveri Company, who now has a branch factory at Paris. In France it has installed five wheels of 10,000 horse-power at the St. Ouen plant in the suburbs of Paris, and also a number of units of the same size in the new St. Denis station, which is now increasing its capacity. At Milan there is installed a 1,500-horse-power turbine in the municipal plant, and in Russia there are two 3,000-horse-power units with three-phase alternators in the St. Petersburg station, besides a unit of the same size at Moscow. In Germany there are many of these turbines in use, the largest being at the Essen plant (7,000 horse-power), and at Frankfort (5,000 horse-power).

There is also considerable activity as regards electric furnace work for the production of carbide and also for electro-metallurgy. It is in this latter branch that we note the greatest progress. Among the arc furnaces are the Stassano, Girod, Heroult and Keller. The Gin and the Kjellin types are induction furnaces. One of the latter has been installed at the Koechling works in Germany, and uses 1,000 horse-power, with a twenty-ton charge. An electric furnace of the Gin type was erected not long since at the Krupp establishment, using a copper bar winding as the primary and the melted metal as the secondary; the primary is cooled by an air fan. The Stassano furnace is used successfully in Italy for steel production, and the new plant at Turin has two large furnaces of 1,000 horse-power each, working at 150 volts and 2,500 amperes, with a run of five tons of metal. Carbide of calcium production is now on the increase. In France one of the new plants is located at St. Marcel, and it is equipped with three furnaces having a total output of 5,000 horse-power. The new Darto establishment will soon have ten furnaces in operation, with a total of 10,000 horse-power. Keller and Leleux are erecting a furnace plant for ferro-silicon which will have three large furnaces, taking 5,000 horse-power. Aluminum is now manufactured in France by the Froges Company, which is soon to use a 40,000-horse-power hydraulic plant, also at the Premont works, which takes 4,000 horse-power. There is erecting a plant at St. Jean de Maurienne which will use 12,000 horse-power, and another in the south of France, at Auzat, which employs a 12,000-horse-power hydraulic plant.

Most of the novelties in the way of arc and incandescent lamps come from Germany, where experimenters are now actively at work upon the osmium, tantalum and other metallic-filament lamps. Some recent patents have been secured, among others for a tungsten lamp filament having a carbon base or core. The Osram lamp, made by a Berlin firm, runs upon 110 to 130 volts, and appears to last for 1,000 hours, at 1.1 watts per candle. These lamps are made in different sizes, from twenty-five to 100 candle-power, and will work on direct and alternating-current circuits. The tantalum lamps are now coming into use, and at Paris there is being introduced a lamp of this kind which is guaranteed at 1.6 watts per candle, and it runs upon thirty-five to 120 volts, being made in sixteen and twenty-five candle-power sizes. In Austria the new tungsten lamps are used in the lighting of St. Stephen's Cathedral at Vienna. They are run on a 220-volt circuit, with two 110-volt lamps in series. The result is very good. At Paris a novel use of incandescent lamps is to be noticed on the Eiffel Tower, where they are placed after the manner of an electric sign, so as to show the hour and minute. A clockwork device which is quite ingenious is used to change the lamps every minute and also each hour during the night. Among the new arc lamps we note a flaming arc in a closed globe, the invention of Tito Carbone. It uses ordinary carbons. A magnet is employed to blow the arc into a half circle, and on account of the added length it uses a higher voltage, eighty-five volts direct, or seventy-five volts alternating current. At 4,000 candle-power it ran on 110 volts and ten amperes. The "Helea" arc lamp, made at Cologne, is said to take less current than usual, this being but 3.5 amperes at 110 volts, instead of ten amperes, and it will burn for sixty hours. The standard size is 1,000 candle-power. A Swiss firm has brought out the "Polaire," a small arc lamp which takes from two to three amperes on 110 volts. The Siemens-Schuckert Company has lately brought out a new system of alternating-current arc, using lamps in series upon a constant-current distribution from a special transformer. In the different cities of Europe are to be seen the mineralized carbon arc lamps for outside lighting, and also the mercury-vapor lamps.

In the field of radiotelegraphy the advance has been considerable during the past year. Referring specially to the work which has been carried out on the Continent, we note the completion of the great station at Nauen, near Berlin, which was erected by the Telefunken Company. It is able to send signals at 2,000 miles distance at present, using the Slaby-Arco system. In Italy the largest plant is the Monte Mario post, which is located near Rome, and at present the government is equipping a number of stations along the coast and also in Sicily. These posts are under the charge of the War Department. In like manner France has a central post at Paris, upon the Eiffel Tower, and can thus connect with all the coast stations both on the Atlantic and Channel coasts,

and also on the Mediterranean. The Eiffel Tower station has not yet received the high-power apparatus which will no doubt be installed in the future, but even now it is able to signal as far as Tunis and also to the vessels of the war fleet in the Mediterranean. It also signals to Morocco, and is thus connected with Casablanca, the seat of the recent military operations in that country. In Germany, most of the coast plants along the North and Baltic seas are equipped with the Telefunken apparatus. It is to be remarked that most of the war vessels of the French, Italian, German and Russian fleets are equipped with apparatus at present. The same system is taken up in France by the Thomson-Houston Company, while the leading Paris makes are the Ducretet, Rochefort and Carpentier. Experiments have been made in the way of signaling to moving trains on the Berlin-Belitz railroad section, with the cars carrying a mast, and these have been fairly successful. The distance covered is about eight miles, which is all that is required here. We should not leave the subject without remarking Professor Branly's interesting work in the matter of operating different apparatus at a distance by means of electric waves. Thus a wave impulse is made to work a switch at the distant post and thus set a motor running. A second wave sent at the proper time will light lamps, etc. His new apparatus gives all the desired control of such actions and, by using a recent device, an accidental spark has no effect. Torpedo steering is one of the practical applications, and this was quite successful on the Mediterranean coast.

At present the longest telephone circuit on the Continent which is working commercially is the Paris-Berlin line, which is about 650 miles long, this being somewhat under the length of the New York-Chicago line. However, Professor Majorana, an Italian scientist, has been able to reach a distance of 900 miles in his experiments made upon the circuit from Rome to London. This is the longest distance yet attained in Europe, and he accomplished this by the use of his new mercury transmitter. As regards the development of city telephone systems, we may note the large telephone exchange which is now building at Hamburg. It will be undoubtedly the largest on the Continent, seeing that it is laid out for 80,000 subscribers. At Berlin there has been formed a syndicate for developing the automatic telephone system. Telephone matters have somewhat improved of late at Paris, where the system had been quite defective owing to lack of proper management. Considerable progress is noted in Italy, where Parliament voted a credit of nearly $2,000,000 for new telephone work in the city of Rome and elsewhere. In Japan, telephone affairs are flourishing, and it is stated that the exchanges of Tokio, five in number, have a total of 15,000 subscribers. The most recent figures give 35,500 subscribers for the whole country. Constantinople will soon have a city telephone system, according to the present projects. Wireless telephony has made considerable progress of late, and there are a number of experimenters at work upon the question. Following the earlier experiments of M. Ruhmer, of Berlin, who used selenium, we have Valdemar Poulsen's interesting apparatus, and this principle has been taken up by a number of others. Professor Majorana used it in connection with his new microphone and could work from Rome to Monte Mario at three miles' distance. But twenty-five miles are now covered, according to the experiments made by the Telefunken Company, between the Nauen station and Berlin, using the Schloemilch receiver.

The Early Days of the Dynamo.

By Sydney F. Walker.

IN the issue of the ELECTRICAL REVIEW of September 7, 1907, Professor William Kent, dean of the College of Applied Science, Syracuse University, asked for information, among other things, as to the early struggles of the dynamo, and in the following article the present writer, who was in the thick of the fight, during a considerable portion of the early days, proposes to give a résumé of those struggles, as fully as is possible within the space available.

The first practical result of Faraday's discovery of magneto-electricity was the appearance of the magneto-electrical machine. The machine known as Saxton's in those days was, the writer believes, the first. It survives to the present day in the so-called Faradaical machine sold by opticians for medical purposes. It had a pair of coils of wire on iron cores, revolving in front of the poles of a permanent horseshoe magnet. It was followed shortly after by the Siemens shuttle armature, designed upon the lines of the well-known weaving shuttle, a coil of wire taking the place of the yarn in the shuttle, and the whole thing revolving within a cylindrical polar space provided for it in castings forming extensions of the poles of a permanent magnet. It survives to this day in the magneto-electrical machines employed for blasting and for the electrical ignition of gasolene and oil engines. It is also practically the basis upon which the later Siemens machine was built up. The very early machines employed for producing currents for electric lighting were multiples of either the Saxton, or the shuttle machine, and were used almost entirely for lighthouse work. In England the South Foreland lighthouse was lighted by an arc lamp, furnished with current by a machine of the kind known as the Holmes, the installation being fitted up, the writer believes, under Faraday's own supervision. In France a lighthouse on the northern coast was also lighted by a machine on somewhat the same lines, known as l'Alliance. About the same time the Wilde machine was introduced. This was practically two machines, one a shuttle-armature machine with permanent magnets, and the other a shuttle-armature machine with electromagnets. The shuttle of the permanent magnet machine furnished current for the field magnets of the larger machine. The Wilde machine, the writer believes, was used almost entirely for electro-plating, but it held the field until a very late period. About the year 1866 Sir Charles Wheatstone, Sir William Siemens (Mr. Siemens, as he then was), and S. Alfred Varley, each independently discovered the phenomenon of the self-excitation of the dynamo. The machines of the three inventors were constructed on very much the same lines. There were flat electromagnets enclosing cylindrical polar spaces at one or both ends, in which shuttle armatures revolved. In the first Wheatstone machine there were two armatures, one at each end of the field magnets, one being employed to furnish current for the field magnets, the other furnishing current for external purposes. In a later machine there was one armature,

and the field magnets were excited by a shunt current. The writer believes that this was the first shunt-wound machine. Previously to this a good deal of unimportant work had been done in the design of small electric motors that could be stopped by the hand, in which a circle of magnets gave motion to a number of pieces of iron arranged radially, and similar arrangements, and in addition, Jacobi, at St. Petersburg, had built a motor on somewhat the same lines, on a sufficiently large scale to enable him to drive a boat by paddles, on the Neva, the current being furnished by acid batteries. Jacobi's work led to nothing, so far as the writer is aware. The first really important advance that was made, apart from those mentioned above, was by Professor Antonio Pacinotti, of Bologna, in 1864. Pacinotti's machine was built for an electric motor, by the professor himself, but was never, apparently, carried beyond the laboratory stage, though it became the foundation of the Gramme and later machines. The armature of the Pacinotti machine consisted of a wheel, with the spokes carried beyond the periphery, and having separate coils of wire wound on the rim of the wheel, between the spokes. The armature was pivoted in a horizontal plane and revolved upon a vertical axle, above the base of the machine, and in a cylindrical space formed by crescent-shaped horns, these latter being the polar extensions of the two legs of a field magnet, also supported from the base of the machine. The ends of all the coils were taken down to what was practically the first dynamo commutator. It consisted of a number of strips of brass forming a cylinder, carried by, but insulated from, the axle of the machine, the strips being insulated from each other, and having two other strips of brass or copper bearing on them. The current was led to the armature through the strips of brass, and thence through the sections of the commutator, to the individual coils, and the armature revolved. In 1870 came the machine of M. Gramme, which was avowedly built upon the lines of the Pacinotti machine, but with certain modifications. Gramme built his armature in the form of a ring, afterward so well known as the Gramme ring. The core was formed of iron wire coiled up into a ring and insulated with calico, and coils of cotton-covered copper wire were wound transversely over and through the rings, in sections as in the Pacinotti, and were soldered to sections of the commutator. The commutator of the Gramme machine is practically the same as the commutator of the modern dynamo, but with the necessary improvements in mechanical construction and electrical insulation. It was a cylinder built up of segments of copper, each segment having a rectangular piece punched out of each end. The segments were insulated from each other by paper, and the cylinder was held together by rings of wood forced into the annular grooves formed in its two ends by the spaces punched out in the individual segments. Flanged brass rings were pushed into grooves turned in the wooden rings, and the brass rings were slipped over the axle upon which the armature revolved. The armature itself was held upon the axle, first, by one wooden hub driven tight into the middle of the armature, the hub being covered with calico to prevent abrasion of the wires as far as possible. The wooden hub had a hole and a key-way for the axle. In later forms the wooden hub was divided into two halves, forced in from opposite sides of the armature. The armature revolved in a polar space, very similar to that of the Pacinotti, formed by crescent-shaped horns, extensions of the poles of the field magnets. In the smaller machines Gramme employed permanent magnets, built on the Jamin principle, in which a number of very thin strips of steel, separately magnetized, were held together inside a containing band. The larger machines had electromagnets, consisting of one, two or more pairs of legs, each pair of legs having its own crescent-shaped horns.

The Gramme machine was followed very soon after by the Hefner von Alteneck, better known as the Siemens machine. The Alteneck machine may be described as an extension of the shuttle armature to the conditions of the Gramme machine. There were the same flat magnets as in the earlier Siemens and Wheatstone machines, but the armature, in place of carrying only one coil of wire, had several coils, covering the whole of its surface. It was built up in fact very much like the Gramme armature, but was very much longer, in the direction of the axle; and had two distinct layers of wire, apart from the number of layers that might be necessary for the pressure to be obtained, as against one layer in the Gramme machine. The commutator was very similar, and carried in a similar manner to that of the Gramme. In 1872, the writer believes, or about that time, M. Fontaine, who was connected with the manufacture of the Gramme machine in Paris, announced the discovery that the dynamo machine was reversible. It would furnish a current when driven by mechanical power, or it would furnish mechanical power if current were delivered to it. In 1875 the present writer was electrician to the Gramme's Magneto Electric Company, the owners of the Gramme patents in the United Kingdom, and a very pretty experiment that used to be shown to visitors to the office at that time was the following: There were three Gramme machines, with permanent magnets, standing on the office table. One of them was wound with comparatively fine wire; a second with comparatively thick, and the third had two windings: one of comparatively thick and the other of comparatively thin wire; two commutators and two sets of terminals. The thick-wire machine was connected to one side of terminals of the double-wound machine, and the thin-wire machine to the other set, and when either the thick-wire machine or the thin-wire machine was turned by hand, the double-wound machine, after a short interval, commenced to revolve, and shortly after the other machine revolved, and the process might be reversed. Also, if the double-wound machine was revolved, it drove the other two. This apparatus, it will be seen, is the forerunner of the motor generator and the double-current generator. At this period matters hung fire, mainly because there was no satisfactory electric lamp. No one dreamed in those days of employing electricity for power purposes, as batteries, the only methods apparently available, were much too expensive. The old Serrin lamp was the only one available, and it was exceedingly exasperating, and was arranged to cast an immense shadow immediately below itself. It was at the Paris Exposition of 1878 that the first fillip was given to electric lighting. Just about this period things were moving in electricity generally. The telephone had just previously been invented, and at the Paris Exhibition Jablochoff introduced his electric candle, which was employed to illuminate the Avenue de l'Opera. The Jablochoff candle needs no description here. At the time, however, it was thought to have solved the problem of the division of the electric light, round which so many minds were working, and it is interesting to note that Jablochoff worked out a system of distribution by transformers, on a small scale, that was practically the forerunner of the present transformer system. The Jablochoff candle was worked by alternating currents, and it was thought at the time that the alternating current presented the practical solution of the

division of the electric light. Another French inventor, M. Lontin, worked out another system of lighting, in which he also employed alternating currents and an improved form of the Serrin lamp. Lontin's alternator was not unlike some of those in use at the present day. It was single phase; two and three phase had not been heard of in those days, and it had a drum with field magnets projecting inward, and other magnets revolving in the polar space inside, the exciting current being provided by a smaller machine, separately driven. Things began to move fairly fast after this. Charles Brush introduced his system of arc lighting, and it is not too much to say that its introduction into the United Kingdom was really the first practical application of electric lighting on a large scale. Previously to Brush's advent English manufacturers had been improving the old Serrin lamp, and had been working at other forms, but they had found that it was necessary to employ one machine for each arc lamp, and they obtained much better results if they had two machines. Brush ran forty lamps from one machine.

The Brockie commutating lamp, which is long since dead, followed very close upon the advent of the Brush, and it proved a very useful apparatus for colliery yards and other places, but there were considerable difficulties in providing the commutating current where the number of lamps exceeded five, and there were constant troubles with the clutch magnet of the lamp. Shortly after this came the invention of the incandescent lamp, and with it the dynamo entered upon an entirely new phase, and it is probably not too much to say that the real work in the development of the dynamo dates from that period. At that time the machines almost universally employed were series wound, and the series-wound machine furnishing current for one arc, and driven by an engine that would vary its speed with the requirement of the lamp, with very wide variations, was perhaps the best arrangement for single arc lamps at the time. But when it came to running incandescent lamps from series-wound machines considerable difficulties arose. In those days fifty volts was the highest pressure for which incandescent lamps were made, and consequently it was necessary to run them in series parallel, and it often happened that when one or two lamps of a parallel gave out, the whole of the parallel followed, as it had to carry the whole of the current coming from the other parallel, and this was usually followed by the complete extinction of the whole of the lamps furnished by the machine. The alternating-current machine did some good service at that time, as it was then constructed, so that several separate circuits could be taken from one machine independently of each other. The shunt-wound machine was then revived, and was employed to a small extent for furnishing current for incandescent lamps. Better results were obtained with it than with the series-wound machine, but it was necessary to provide a regulating resistance for the field magnets, a troublesome matter in those days, or to vary the speed of the driving engine, if any of the lamps were turned in or out. About this time came in close succession the first Electrical Exhibition at the Crystal Palace, in 1882, with the wild rush of company promotion immediately succeeding; a little later the expiration of the Gramme patent, and shortly after, the promulgation of the law of the magnetic circuit by Dr. John Hopkinson and Gisbert Kapp. Previously to the promulgation of the law of the magnetic circuit, electrical engineers who were building dynamos were plunging around the problem, gaining experience by the expensive method of trial and error, and the results were often very exasperating. There was a machine, for instance, known as the "A" Gramme, which supplied two arc lamps, or forty sixteen-candle-power incandescent lamps. A slight increase in the length of the machine, and in the length and diameter of the armature, produced a machine that would light sixty incandescent lamps, and that would do its work very much more satisfactorily than the "A" Gramme ever did: but a further extension, which was hoped would produce a 100-light machine, was most unsatisfactory. With the promulgation of the law of the magnetic circuit, however, all became plain sailing, and from that time the development of the dynamo has been practically continuous. About this time, also, the compound-wound machine was introduced. Brush had used a shunt coil on some of his machines, for a special purpose, which he called a "teaser," and it is probable that this was the first practical application of a shunt coil to a series machine. The practical development of the compound machine, aided by the law of the magnetic circuit, rendered the development of dynamo construction comparatively simple, though there was still a great deal to be done before it reached the satisfactory results of to-day. An important point that came up just at this time was the use of the dynamo as a motor. At first it was thought that different construction was needed for motors and for generators, and the idea was justified to a certain extent, from the fact that some of the generators of that date, when put to act as motors, broke up. The important point of the mechanical construction of the machine, and particularly the mechanical connection between the axle, the core of the armature, and the wires had not been considered, mainly because the machines were so small and the power absorbed by them comparatively trifling, and, further, there was also a very flexible agent transmitting the power between the driving engine and the axle of the dynamo. The question of the mechanical transmission of the power from the axle to the wires on the armature was not of so much importance as it afterward became. Further, electrical engineers of that date were terribly afraid of sacrificing anything in the matter of insulation. It was some time before the important advance that was made by a few firms, in the substitution of thin iron discs, in place of wire for the cores of the armature, became general, and it took a much longer time for the substantial mechanical construction which rules in all machines at the present day, thoroughly to establish itself. There was always the struggle between the requirements of insulation and those of mechanical transmission. Two important cases that directed the attention of engineers to the point may be mentioned. When certain dynamos which were giving every satisfaction as belt or rope-driven generators were arranged as motors for driving some of the early tramcars, the current being furnished by accumulators, the armatures broke up. The mechanical connection between the spider supporting the armature core and the core itself would not stand the heavy strains on starting the car. The other instance is that of a continuous-current dynamo, designed to furnish a very large current, the conductors being merely laid on the outside of the armature, as was common in those days. When driven, the axle and core of the armature turned round inside of the conductors, no current, of course, being furnished.

The Pacinotti, or toothed-core construction, was brought up from time to time, but in the early forms it was not very successful. It was supposed to give a more efficient machine, and a stronger one mechanically: but as constructed in those days, the efficiency was lower, the sparking at the commutator was very much increased, and the machine heated up very

much more than the ordinary smooth-core armature. At that time the real reasons for the employment of the laminated core, and the method of making the slotted-core armature more efficient than the old smooth core, were not appreciated, as they are at the present day, and the Pacinotti construction was abandoned for a time. The development of the electric lighting and power business, demanding larger and larger machines, obliged electrical engineers to look into the problem of mechanical construction again, and the result has been the development of the present form of slotted-core armature, running fairly close to the poles, giving good mechanical construction and high efficiency.

There is not space to give an account of the development of the alternating-current machine. It has had a very curious life. At times it has been considered to be the machine for the purpose, and shortly after it has had no friends whatever. Its development has been very much on the lines of its own characteristic curve. At each new development it has been constructed on entirely different lines, and it is probable that the work of Tesla and others and the development of two and three-phase machines have done a great deal to establish the alternating-current machine, in its present position, this result being, however, largely due to the facility that alternating currents present for economical transmission to a distance.

A Plea for the Physical Treatment of Alternating-Current Phenomena.

By Lamar Lyndon.

THE tendency, which has so long existed, to express, mathematically, all electrical phenomena and allow the hapless peruser to glean from involved equations—if he can—a true idea of the things which take place, is now yielding to the more rational, natural and easily understood physical expressions.

Mathematics is a useful tool whereby the quantitative relations of all the factors involved in physical phenomena are determined, and in rare instances, previously unsuspected phenomena are discovered, but to obtain a physical conception of electrical phenomena—a mind picture of what is actually happening—from a mathematical equation is more than the ordinary human intelligence is capable of, unless trained to a point unreached by the great majority of engineers.

By a most unfortuitous circumstance, the form of alternating-current waves from dynamoelectric machines has generally approximated to a sine curve. This undoubtedly makes calculations simpler than they would be if the wave were of a complicated shape—or at least not resolvable into a fundamental wave with its upper, odd harmonics. It is, however, the means whereby the alternating-current art has been so clouded and obscured that it is even now generally believed that only the peculiarly gifted can even study it intelligently, and the mind that has mastered this subject must have attributes scarcely short of divine.

Since there was neither occasion nor opportunity for the mathematical fraternity to befog the direct-current art with anything more involved than arithmetic, and in point of fact, the experimenter and physicist "got there first," every amateur, or dynamo-tender understands continuous currents; but alternating, pulsating and oscillatory currents are far beyond and above them, and yet all these latter phenomena are as simple and as easily understood as are the continuous-current actions, provided they are both presented in the same way, and that is physically.

For instance, in a continuous-current circuit with a given potential of, say, 100 volts, if a motor, having a total resistance of two ohms be connected to this circuit, the veriest novice would not predict a current flow of fifty amperes, because he would know that a counter-electromotive force of about ninety volts will be set up when the motor is running, leaving only a net, resultant potential of ten volts to send current through the motor, and therefore the amperes would be five instead of fifty.

But when self-induction in an alternating-current circuit is discussed, this simple relation is not shown, it seems. We are told that self-induction causes a most wonderful upsetting of all the conditions which obtain in a normal non-inductive circuit, and is wholly different from anything that can and does happen in a continuous-current circuit. It appears that an "angle of lag"—whatever that may mean—is produced and with it its twin brother power-factor. Also the "wattless" current manages to creep in further to complicate an unhappy situation. Sines, cosines and tangents flourish luxuriantly. The current flow is diminished, but no energy is lost, although the apparent watts are greater than the actual.

How simple the whole thing becomes when it is explained that a current always sets up magnetic lines and when magnetic lines change in position or quantity, an electromotive force is induced. In consequence of a rapid changing of current in an alternating-current circuit, the magnetic lines of the inductance are also continuously changing and producing an electromotive force, which is the same in character as that developed by the rotating armature of a motor. If the voltage produced by the self-induction, and which opposes the current flow, be subtracted from the voltage of the line, the remaining or net potential will force current through the ohmic resistance of the circuit in exact accordance with Ohm's law, without "power-factor," "angle of lag," "wattless current" or any other disturbing function; just the same as a motor having a counter-electromotive force, which, subtracted from that of the line leaves the net.

There is, however, more to be considered from the mathematician's obscuring standpoint, which is the claim that inductive potential subtracted from the line potential does not leave, as a remainder, the net potential which forces the current through the circuit. Nevertheless, this is absolutely true, provided it be remembered that the inductance does not dissipate energy. It absorbs a given amount of energy on one-half—say the positive—cycle and restores it to the circuit on the next, or the negative, half of the cycle; that is, subtracts from the energy part of the time and adds to it another part of the time. The greater part of the time, however, its electromotive force is opposing the flow of current, while a small part of the time it is actually assisting the current flow. If the subtraction of the inductive volts from the line volts be made algebraically—which is simply physically, that is to say, subtract the inductive volts

when the two electromotive forces are in opposition, and add them when they act together—the net volts remaining will, according to Ohm's law, send current through the circuit.

Again, the contention of the mathematician is that the so-called phase, or time relation, prevents this subtraction. Yet, if a continuous-current motor should run for half an hour at one speed, and by means of a heavy load or prony brake run the next half hour at some lower speed, and then for half an hour be blocked still, generating no counter pressure, and the last half hour be driven at a speed higher than it runs when acting as a motor to produce a potential higher than that of the line, would the computation, by simple arithmetic, of the current flow and the net volts acting on the resistance of the motor be difficult? It would, on the contrary, be perfectly simple. This would merely correspond to a variation in the motor's electromotive force passing through a stepped cycle of two hours' frequency. If the periods of time were extended or decreased the conditions would be the same and just as easily computed. If the variation in speed of the motor should change gradually up and down, at each moment there would be some potential which physically combined with that of the line would give the net electromotive force to send current through the motor. In this respect an inductance in an alternating-current circuit differs in no wise from the foregoing direct-current analogy.

The subtraction (algebraic) must be made for exactly corresponding instants of time, and if thus computed the current flow for that exact instant will be the net voltage divided by the ohmic resistance of the circuit.

Another seemingly difficult subject is that of volt-amperes as related to actual watts. Why does not the product of volts by amperes equal the watts in all cases? This is physically explicable in two ways. One is that the electrical measuring instruments of commerce register stolidly and immovably, not the volts or amperes as they rapidly change from zero to a maximum and back again to zero, but they take a position which indicates the average (or more correctly the square root of the mean square) of the volts, or amperes. Obviously, instruments thus constructed, with so much inertia in their moving parts that they can not follow the rapid fluctuations, while useful to indicate a given potential or heating effect, should not be made the basis of a new and complicated theory of alternating-current phenomena; but unfortunately they are; the phenomena are adjusted to commercial instruments for convenience sake, with X's, Y's and J's trailing behind, and the investigator struggles helplessly amid a fog that physics easily clears, but mathematics only thickens.

If instruments which would register the volts and amperes at any instant for that instant, following all the cyclical changes in these—such as the oscillograph—were employed to measure alternating-current energy, and the eye could at any instant note the readings of the instruments, the product of volts by amperes would be the true watts of the circuit. When the product of volts by amperes as read on ordinary commercial instruments is greater than the true watts, the reason is simply because the volts and the amperes—or rather their averages—are not happening at the same instant. The so-called "power-factor" is only a measure of the difference in time-period between the instant when the amperes reach their average value and the volts attain to theirs, the time of a whole cycle being the unit.

Impedance, which is written mathematically $\sqrt{R^2 + (L\,w)^2}$ is, physically, an erroneous combination, however useful it may be for purposes of computation. Current is equal to $\frac{E}{\sqrt{R^2 + (L\,w)^2}}$; but physically $I = \frac{\sqrt{E^2 - (L\,w\,I)^2}}{R}$ for this latter is a physical relation showing that the current is equal to the line potential minus that of the inductance, the square root of the difference of the squares being simply a mathematical necessity for numerical results because of the difference in time between the instant when the line potential reaches its maximum value and the inductance potential reaches its maximum, and this is due entirely to the character of instruments which are used. If a voltmeter which could follow the changes in voltage were connected across the line and a similar one across the terminals of the inductance, the current would be equal, at any instant, to $\frac{E - e}{R}$, in which E = line voltage and e = inductance voltage.

The foregoing is merely illustrative of the ease with which the whole alternating-current art may be explained and made as clear and simple as continuous currents.

After a thorough understanding of the subject has been attained, the conventional mathematics may then be put forward, but the fact should never be lost sight of that the equations and diagrams are simply convenient ways of computation made necessary by reason of the kind of measuring instruments available and do not really represent the phenomena themselves.

Progress of the Kashmir Power Scheme.

The Kashmir (India) hydroelectric power scheme has made great progress, and it is confidently expected that within a year from date it will be, in so far as the first installation is concerned, completed.

The following brief descriptive account, taken from the *Indian Electrical, Mechanical and Textile News*, may be of interest:

In 1904, at the special invitation of the Kashmir Durbar, Major de Lotbiniére, by whom the Cauvery power installation (the pioneer scheme of this nature in the East) had been recently brought to a brilliantly successful issue, visited Kashmir to investigate and report upon the possibilities of water power development in the territories of the Maharaja.

As the result of preliminary investigations and survey work extending over several months, Major de Lotbiniére recommended the harnessing of the Jhelum in the vicinity of Rampur, where the conditions were found to be more favorable than at any other point.

The river here falls at the rate of about seventy feet per mile, thus affording a working head of 400 feet, with a supply channel of less than seven miles, natural features at the same time providing other requisite essentials in the form of suitable sites for the forebay and power-house, etc.

Rampur is, furthermore, very centrally situated as regards that portion of the Jhelum river exploitable for power development, and is but fifteen miles below Baramoola and fifty-five from Srinagar.

The limits of the power works extend from Baniar, at mile 85 on the Jhelum valley road, where the intake or head work is located, to Mohora, mile 78, the site of the power-house.

Preliminaries having been settled, and Major de Lotbiniére's proposals and recommendations accepted, the services of that officer were placed at the disposal of the Kashmir Durbar by the government of India early in 1905, and by the end of May work upon construction had actually commenced.

It was decided to construct at once river and channel works of capacity sufficient for the development of 20,000 horse-power, with the power-house containing accommodation for about half that quantity, the first installation to comprise four units of 1,000 kilowatts each, about 5,300 horse-power in all, and future extensions or installations to be added as required. The headwork or intake is situated opposite the ancient temple on the Jhelum

valley road at Baniar, and the supply channel (six and one-half miles long) runs thence *via* Rampur and Chenanwari, to the power station at Mohora.

This channel, which has a capacity of nearly 600 cubic feet per second, consists of about 9,000 feet of masonry-lined duct through boulder soil, the remaining portion (25,000 feet) taking the form of a rectangular wooden flume of the type ordinarily used in America. The adoption of wooden flume (here of deodar, so prolific in Kashmir) on so large a scale is necessitated by the nature of the hillsides along which it runs, thus leaving the engineers no other alternative.

The construction of this channel and flume presented many difficulties, all of which have apparently been most successfully overcome. In the comparatively short length of six and one-half miles there are some thirty chains of deep cut and cover, six rock tunnels aggregating 2,100 feet, five aqueducts of eighty feet span, over streams and deep gorges, several minor aqueducts and several protective works against avalanches in the shape of heavy cribwork overshoots, snowsheds, etc. Owing to steep hillsides above it has been necessary to roof the channel and flume, practically from end to end, to preclude all possibility of earth, etc., being carried into it.

A large settling or silt basin has been provided as near the headworks as possible through which the channel flows. Here the velocity of the water will be reduced from some eight feet to less than one foot per second for about ten minutes, which should efficiently clear the supply of silt during periods of turbidity in the river. A small suction dredger will clear the bed of the basin, which is four feet below that of the channel, as required.

Through the rock tunnels, encountered on the flume line, the water will, in cases where the rock is perfectly sound, be passed direct, but where this is not the case, the wooden flume will be carried continuously through them.

It may be mentioned in passing that the quantity of deodar timber used in the construction of the wooden flume will be about 650,000 cubic feet. This, together with the poles for the transmission line, has all been obtained from the local forests.

The grade of the channel, which is constant throughout, is 105 feet per 1,000, or about five and one-half feet per mile, the river here meanwhile falling at the rate of over seventy feet per mile, as already stated.

The dimensions of the masonry-lined channel are eleven feet width and eight and one-half to nine and one-half feet depth, those of the wooden flume being eight feet four inches and eight feet six inches, respectively. Depth of flow at full supply for 20,000 horse-power will be eight feet.

Arrived at Mohora the channel debouches into the forebay, a kind of regulating tank situated on the lower steps of a piece of tableland overlooking, and some 450 feet above, the Jhelum at this point. The forebay contains the usual compartments isolating each pipe inlet, ample waste weir sill, over which all surplus water passes to an adjacent nullah on the flank, and thence to the river again below the power-house, and grids of iron bars effectually intercept all floatable matter, and prevent its ingress to the inlets. Through the outer or front wall of the forebay, and down the face of the steep hillside, the steel pipes or penstocks convey the water to the wheels in the power-house, before reaching which they pass beneath the main cartroad.

The pipes, of which there are four, are of riveted and welded steel, the diameters thirty-six and thirty inches at top and bottom of the lines, respectively, and length of each approximately 750 feet, the fall or head being, as previously mentioned, 400 feet.

The water, having done its work upon the wheels to which the generators are directly coupled, passes through short tail races below the floor to a common spill channel and thence to the rapids, some five chains beyond the down-stream end of the power-house.

The latter is an imposing structure in granite and red brick, standing between the cartroad and the left river bank, from the edge of which it is about 150 feet inland.

It is a double-gabled building, about 190 by eighty-six feet and sixty feet in height. It has a self-contained workshop and traveling crane of twenty-five tons' capacity. The transformers as well as the generators are located in this building, all switchboards and regulating apparatus, etc., being accommodated on a gallery twenty feet above main-floor level.

Each of the four units now being installed comprises a 1,000-kilowatt generator, coupled direct to an Abner Doble needle-nozzle water-wheel of the improved Pelton type, the latter being of 1,765 horse-power. Two exciters, with their direct-coupled water-wheels and a motor-generator set, with six transformers, complete the present installation.

The transmission line, now well advanced, consists of a double line to Baramoola (twenty-one miles), and a single line for the present thence to Srinagar, a further distance of thirty-three miles. The pole structures are of the gallows type, each comprising two verticals, thirty-five feet in length, with two cross-arms. These are spaced on an average at 250 feet apart, and carry a telephone line on a small cross-arm suitably placed below the lower main cross-arm.

The tortuous course of the river necessitates many crossings, of which there are spaced on an average at 250 feet apart, of line between Mohora and Baramoola. Thence to Srinagar the valley opens out and the country traversed is comparatively easy. Substantial wire nets have been constructed below the line wires at every point where these cross the public road for the prevention of accident from a falling wire.

The system is for alternating current, three-phase, frequency twenty-five, delivered at 60,000 volts, the generating voltage being 2,300.

This pressure (60,000) is the highest at present in use upon long-distance transmission in India. The transformers have, however, been designed for delivering at 30,000 or 60,000 volts as may be required, and it is probable that for some time to come the system will be worked at the lower voltage.

The substation at Srinagar, which is located in the state silk factory enclosure, is almost finished. Here the voltage will be reduced to working limits by means of the usual step-down transformers.

The substation at Baramoola is somewhat of a novelty, being a floating one, so designed to enable it to follow the dredging fleet as required, the power being received and distributed by means of flexible cables from the feeder lines on the river bank to the transformers in the floating substation and thence to the dredgers themselves.

The whole of the power available from the first installation will be absorbed by the requirement of the dredging operations, and those of the state silk factory, where the electric current will be used for heating the filature basins, of which there are several thousand in use.

This latter is an interesting and unique feature of the scheme, inasmuch as it is the first time that electric heating has been adopted in the silk industry in any part of the world, and the same may be

said as regards the operating of the huge dipper dredge, which will also be the first of its kind to be so actuated.

The lighting of Srinagar will, it is understood, be shortly taken up, but this, of course, is quite a side issue, and will utilize but a comparatively insignificant amount of the power available.

Baramoola has for the last eight months presented a scene of extraordinary activity, and the hulls of the whole dredging fleet, some fourteen vessels in all, are now nearly completed, and most of them already in the water. Meanwhile the plant and machinery to be installed in them has been regularly arriving at site, and it is hoped that the erection and fitting of the same will make great strides during the forthcoming winter. The dredging operations, which will extend for a distance of over twenty miles, commencing from just below Baramoola, will, it is anticipated, so improve the régime of the Jhelum as to reclaim some 100,000 acres of highly fertile land, which under existing conditions is almost perpetually inundated and so practically useless.

Oil and woolen mills are, among other industries, likely to follow the establishment of cheap power in the state in the near future.

Nothing appears to have been definitely settled with regard to the Kishmir railway, but this must come, and that at no distant date, as the Maharaja is anxious to see this improved communication within his territories.

The cost of the power scheme will, it is understood, be about fifty lakhs ($1,600,000), and the increase of revenue due to the dredging operations alone will, if anticipations are realized, as they doubtless will be, afford the state a good return upon the outlay.

The whole of these vast works is being carried out under the direction of their originator, Major de Lotbinière, the head of the newly organized Kashmir electrical department.

Northern Telephone Society.

The Northern Telephone Society met at the Bell Telephone Building, Syracuse, N. Y., on December 27, about 200 telephone men from all over the state being present. The following officers were elected: President, S. N. Vines; vice-president, S. P. Young; secretary-treasurer, W. S. Schornstheimer; governor to serve three years, C. W. Hitchcock. All of the officers belong to Syracuse, except Mr. Hitchcock, who resides in Utica.

ANNUAL CONVENTION OF THE INTERNATIONAL INDEPENDENT TELEPHONE ASSOCIATION.

COLISEUM ANNEX, CHICAGO, ILL., JANUARY 20-23.

The annual convention of the International Independent Telephone Association will be held in the Coliseum Annex, Chicago, Ill., January 20-23.

On Monday, January 20, there will be a meeting of the executive committee at 1.30 P. M. At 2.30 P. M. there will be a meeting of the advisory board.

On Tuesday, January 21, at 10.30 A. M., there will be a meeting of the committee in charge of details, reception and registration of guests. At 2 P. M. the convention will be called to order.

The following programme has been announced:

Invocation.

Address of welcome—Hon. F. A. Busse, Mayor of Chicago.

Response—M. L. Clawson, Indianapolis.

President's annual address—Theodore Gary, Macon, Mo.

Officers' reports. Appointment of committees. Written reports of state, territorial and provincial associations.

Papers and addresses as selected. Discussion after each subject.

"Present Problems and Their Solution." A general discussion of practical subjects.

Question Box.

Adjourn for the day.

WEDNESDAY, JANUARY 22, 10.30 A. M.

Invocation.

Report of entertainment committee. Discussion and action.

Report of committee on resolutions. Discussion and action.

Papers and addresses as selected. Discussion after each subject.

Question Box.

Adjourn for the day.

Eight-thirty P. M. — Complimentary smoker in convention hall. Music, refreshments and special programme.

THURSDAY, JANUARY 23, 10.30 A. M.

Invocation.

Papers and addresses as selected. Discussion after each subject.

Reports of miscellaneous committees.

Report of nominating committee. Discussion and action.

Election and installation of officers.

Transaction of miscellaneous business.

Presentation of new business.

"Our Future Policy." Free for all discussion regarding work to be taken up during the coming year.

Convention adjourns.

The following is a list of papers and addresses which will be presented at the convention:

"The Independence of the Independents," by W. H. Denlinger, Patton, Pa.

"Independent Toll Lines," by Albert Parlett, Bristol, Va.

"How to Raise Rates," by L. A. Herrick, Freeport, Ill.

"Business Methods in the Telephone Business," by C. B. Cheadle, Joliet, Ill.

"The District, State and International Associations," by A. C. Lindemuth, Richmond, Ind.

"Best Methods of Enlarging Association Work," by Manford Savage, Champaign, Ill.

"Practical Advertising—Boosting the Shield," by W. H. Caman, Beatrice, Neb.

"Independent Requirements in Canada," L. Page Wilson, Toronto, Can.

"Where the Money Comes From," by Chas. West, Allentown, Pa.

"Depreciation of Telephone Properties as Compared With Other Public Utility Corporations," Geo. S. Shanklin, Lexington, Ky.

"Financing Methods to Meet Modern Requirements," by W. L. Stanton, Cleveland, Ohio.

"Measured Service—A Fair Basis for Company and Subscriber," by W. H. Crumb, Chicago, Ill.

"The Business End of the Business," by James H. Shoemaker, Waterloo, Iowa.

"What Is Your Telephone Directory Worth?" by W. A. Wadsworth, Chicago, Ill.

"Telephone Investments—Quit Knocking—Boost!" by Max Koehler, St. Louis, Mo.

"Combatting the Sub-License Company," by Frank L. Beam, Columbus, Ohio.

"How the State Directory Helps Business," by R. E. Mattison, Lincoln, Neb.

"Telephone Directories," by G. R. Johnston, Columbus, Ohio.

"All-Cable Plant—Reducing Cost of Maintenance," by J. K. Johnston, Sandusky, Ohio.

"Economy in Perfect Organization," by F. D. Houck, Harrisburg, Pa.

"Local Publicity," by R. Max Eaton, Niagara Falls, N. Y.

"The Banker's Opinion of Securities," by E. H. Moulton, Minneapolis, Minn.

"Toll Line Advertising," by J. B. Earle, Waco, Texas.

"Aerial and Underground Construction," by C. H. Judson, Seattle, Wash.

"Winning Home Support in New Fields," by T. S. Lane, Butte, Mont.

"The Mistake of Giving Free Toll Service," by Frank E. Ebersole, Portland, Me.

"The Situation in the South Atlantic States—The Reason," by E. S. Moorer, Anderson, S. C.

"Relation of Cost of Service to Quality," by John E. Casey, St. Louis, Mo.

"Telegraphing Over Telephone Wires—Money-Making Possibilities," by C. Y. McVey, Cleveland, Ohio.

"Electrolysis—Cost and Prevention," C. H. Ledlie, St. Louis, Mo.

"Joint Occupation of Pole Lines," by C. E. Tarte, Grand Rapids, Mich.

"Hotel Branch Exchanges," by A. H. Cowie, Syracuse, N. Y.

"Slot Machines and Pay Station Signs," by O. F. French, Winnipeg, Man., Canada.

"Why the National Grange Favors Competition," by Geo. W. F. Gaunt, Mullica, N. J.

CHICAGO—AN ELECTRICAL CITY.

A Commentary on the Electrical Conditions of Chicago, Ill., as Respects the City Electrical Department, the Electric Lighting, Street Railway and Telephone Utilities and the Manufacturing Interests.

PROBABLY no city to-day is so much in the public eye as Chicago, Cook County, Ill. The recent litigation and political contest between the municipality and the street-railway interests, the consolidation of the Chicago Edison Company and the Commonwealth Electric Company, and the controversy of the municipality and the telephone interests, resulting in a new franchise granted to the Chicago Telephone Company, have focused attention on this city, and out of this local turmoil there has been evolved a relationship between the city and the public service corporations which will lead to improved conditions in every large municipality in the country. So sanely and wisely have the corporations met the issues thrust upon them, and so painstaking has been the effort of the city council in realizing and recognizing the rights of the corporations, that Chicago stands to-day very much in the form of a model for other large cities to copy.

Chicago, electrically, emulates the symbolism and meaning that its name implies. In the old history of the Indians, Chicago has ever meant something mighty. Since the first white men, presumably Louis Joliet and his fellow-traveler, the Jesuit missionary, Jacques Marquette, explored the Illinois river in 1673, this part of the country has been prolific of stirring achievements and interesting developments. Chicago was founded in the summer of 1803, when Captain John Whistler, of the United States Army, erected Fort Dearborn, in honor of General Henry Dearborn, then secretary of war. At that time the settlement comprised three or four cabins, occupied by French Canadian traders. In 1812 the city was practically wiped out in the massacre of Fort Dearborn, but the fort was rebuilt on a larger scale and settlers began coming into the region in great numbers. At the close of the Black Hawk War, in 1832, the collapse of Indian supremacy east of the Mississippi was complete, and, in 1833, Chicago, with barely the 150 inhabitants necessary for incorporation, became an incorporated town. Four years later it was incorporated as a city, with an area of about ten square miles. In 1903 the area was a trifle under 200 square miles, and the population was estimated at 2,241,000. The great Chicago fire, in the autumn of 1871, practically wiped the city off the map, destroying three and one-half square miles of property, valued at about $200,000,000, and sacrificing over 200 lives. At that time the population was about 300,000.

In point of population Chicago is the second largest city in America, and in point of magnitude and importance of its manufacturing and mercantile activities it is not admitted that it is second to any. Chicago holds a unique strategic position as one of the industrial centres of the United States, and its ramifications into extensive operations in food products, cereals, steel rails, machinery and other merchandise render it the Mecca of hundreds of thousands of traveling business men. It is in reality the home of the branch offices of every important business house east or west of the Mississippi river.

Chicago contains the termini of twenty-six railroads, aggregating 90,000 miles of railway, and if Chicago is to be congratulated upon anything it is upon its maintenance of a condition which causes every person passing east or west to stay and leave some of his wealth in the city. In other words, there is no through train east or west through Chicago. One-third of the total railway mileage of the United States is focused and pours its concentrated wealth of traffic into the Chicago market. There is also a large amount of freight handled by the fleets on the Great Lakes, which ply between Chicago and the eastern ports.

While the suburban districts of Chicago offer splendid residence facilities, the business portion of the city is confined to a congested peninsula bounded on three sides by Lake Michigan and by the branches of the Chicago river. The retail shopping district is really only seven blocks long and five blocks wide. Right in the heart of the city are located the principal hotels, clubs, musical colleges and studio buildings. The art institute and public library, the Field Columbian Museum and the World's Fair Art Building are all either in or near to the city. One of the show features of the shopping district is the great mercantile establishment of Marshall Field & Company. In this great department store is housed one of the most elaborate isolated electrical equipments in the world, and the sixteen-candle-power equivalent in electrical apparatus is equal to the combined loads of several small towns.

In educational work Chicago is the home of the University of Chicago, located near Jackson Park. This is one of the youngest and largest universities in the United States, with a present endowment of $15,000,000, but also supported by the powerful influence of Mr. Rockefeller and other wealthy and public-spirited men. Lewis Institute, the Armour Institute of Technology, and the American School of Correspondence also form a part of Chicago's chain of institutions for technical education.

Three years ago the first electrical show, held under the auspices of the Electrical Trades Exposition Company, was inaugurated, and this exposition demonstrated the importance of Chicago as a market place for electrical apparatus produced by manufacturers throughout the whole country. It is significant that although the manufacture of electrical products is not carried on to any great extent, except by one or two strong companies, in or near Chicago, there are more representatives of electrical manufacturers located in this city than in any other city in the world. The aggressive work carried on by the Chicago Edison Company and Commonwealth Electric Company has made possible the slogan, "Chicago, the Electric City." Chicago is a city of lights. In fact, the enterprising business men indulged to such an extent in electric signs that the results proved far from satisfactory from an æsthetic point of view, and a city ordinance now prohibits the use of certain forms of signs in one district of the city.

What follows is an attempt to condense in as brief form as possible a summary of the present condition of the various elec-

trical utilities in Chicago. No single issue, however comprehensive, could tell in detail the immense developments which are found here. The extensive and complicated service of the lighting companies, the tremendous rehabilitation of the street-railway corporations, and the important development of the Sanitary District trustees near Lockport, together with the network with which the telephone companies have girdled the streets of the city, would each by itself require volumes to describe.

The City Department of Electricity.

THE department of electricity was established by city ordinance in 1898. Previous to that time the city's electrical work was supervised by the superintendent of city telegraphs, and the work was carried on as a branch of the fire department, the superintendent being appointed by, and being subject to, the fire marshal. The same ordinance which established the department created the office of city electrician, who is appointed by the mayor, by and with the consent of the city council, and who is the head of the department of electricity. He has the management of the fire-alarm-telegraph and police-telephone systems, of municipal lighting, of the inspection of all electric wiring within the city, both inside the buildings, above, beneath and upon the surface of the streets, and of all electrical matters in which the city is interested; and he appoints, in accordance with law, all subordinate officers and assistants in his department.

The ordinance provides for proper control by the fire marshal of all fire-alarm operators and the location of fire-alarm boxes. The ordinance also provides that in all matters pertaining to the electrical service of the police department the city electrician shall consult with the superintendent of police.

There are in the department of electricity about 500 officers and employés. The department is under the direct supervision of William Carroll, city electrician.

The city now maintains 8,050 arc lamps, using power from its own stations, and buys current from the Commonwealth Edison Company for 600 arc lamps, the transmission circuits, poles and lamps being owned by the city. In addition, there are 25,000 gas lamps and 7,000 gasolene lamps. Thirteen thousand of the gas lamps are equipped with mantle burners, the balance being flat-flame gas burners. By the end of this year it is expected that the city department will maintain 13,000 arc lamps.

The city operates four stations, namely, the H. N. May plant, the R. A. Waller plant, both named for former comptrollers; and plant No. 6 and plant No. 8. These plants are equipped with miscellaneous apparatus, the arc lamps, for the most part, being the old-style, direct-current lamps. For the past two years all extension and improvement work has been done with the idea of adopting alternating-current enclosed arc lamps. The North Side lamps, which were formerly operated with from 150 to 170 direct-current arcs to the circuit, have been rearranged and subdivided into fifty and eighty-light circuits, the open arc lamps having been changed to alternating-current enclosed lamps. These are now being operated from the H. N. May plant.

The city has completed arrangements with the trustees of the Sanitary District of Chicago to receive power, early in the year, from the power plant which is being developed on the Chicago Drainage Canal. When the transmission circuit from the Drainage Canal has been completed the city will establish substations in the various centres of distribution, each station designed to contain three 250-kilowatt transformers and twenty-four regulators, and to operate 1,200 arc lamps on fifty-light circuits. The electromotive force will be stepped down from 12,000 to 4,000 volts. At the four stations where the steam-driven apparatus is at present installed, synchronous motors will be connected to the generating machinery, taking current direct from the Drainage Canal transmission lines.

The power plant of the Sanitary District of Chicago is located two miles above Lockport, about thirty-three miles from Chicago. It is laid out for eight three-phase, sixty-cycle, revolving field alternators, each having a capacity of 4,000 kilowatts at eighty-five per cent power-factor. These alternators will be driven by horizontal water-wheels, and excitation current will be furnished by three 250-kilowatt, 250-volt exciter sets. Up to the present time the Sanitary District has contracted with the Crocker-Wheeler Company, of Ampere, N. J., for five 4,000-kilowatt alternators and two 250-kilowatt exciter sets. Three of the alternators and two exciter sets are now completely erected, having been turned over, tested, and are ready for service.

The four alternators and the two exciter sets are driven by Wellman-Seaver-Morgan Company's horizontal water-wheels, and the fifth alternator is to be driven by a horizontal turbine built by the S. Morgan Smith Company, of York, Pa. The generators are wound for 6,600 volts, the voltage then being stepped up to 45,000 volts for transmission. The water-cooled transformers at the power-house and at the substation have been furnished by the General Electric Company, which is also furnishing all the switchboard apparatus.

SAMUEL INSULL,
President Commonwealth Edison Company, Chicago, Ill.

The Commonwealth Edison Company.

CHICAGO has always been a most fertile field for central station service. As far back as eighteen years ago there were in existence the Chicago Edison Company, the Chicago Arc Light and Power Company, and a little later the Englewood Electric Light Company and a number of others. Up to the fall of last year there were two strong companies—the Chicago Edison Company and the Commonwealth Edison Company, both serving an extensive territory and operating more or less independently, although along closely affiliated lines. At stockholders' meetings of the Chicago Edison Company and the Commonwealth Edison Company, held on September 16, these two companies were formally consolidated, all of the stock of the Commonwealth and over ninety-five per cent of the stock of the Chicago Edison Company being represented. At each meeting the vote was unanimous for consolidation. The name of the merged companies became the

Commonwealth Edison Company, the headquarters remaining in the Edison

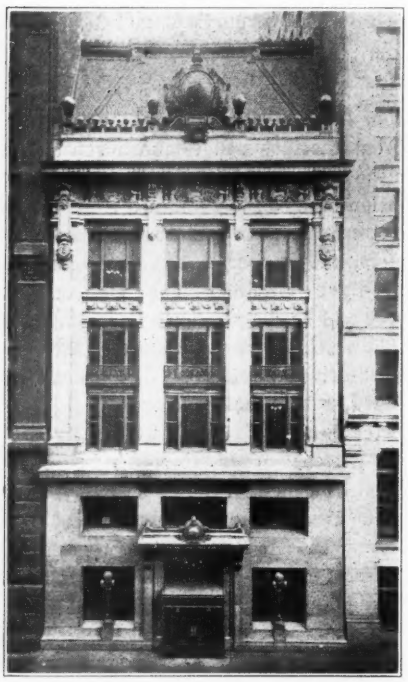


FIG. 1.—THE OFFICE BUILDING OF THE COMMONWEALTH EDISON COMPANY AT 139 ADAMS STREET, CHICAGO, ILL.

Building (a view of which is shown in Fig. 1), at 139 Adams street.

EXPLANATION
GENERATING STATIONS
SUB STATIONS DISTRIBUTING DIRECT CURRENT
SUB STATIONS DISTRIBUTING DIRECT CURRENT AND SUBSIDIARY STEAM PLANT
SUB STATIONS DISTRIBUTING ALTERNATING CURRENT
SUB STATIONS DISTRIBUTING ALTERNATING CURRENT AND SUBSIDIARY STEAM PLANT

FIG. 2.—COMMONWEALTH EDISON COMPANY'S, GENERATING STATIONS AND SUBSTATIONS, CHICAGO, ILL.

The Commonwealth Edison Company has a capital stock of $30,000,000 and operates under the Commonwealth franchise, which covers the territory of the city of Chicago and has nearly forty years to run. The officers are: President, Samuel Insull; first vice-president, Robert T. Lincoln; second vice-president, L. A. Ferguson; secretary and treasurer, W. A. Fox; purchasing agent, R. C. P. Holmes. The board of directors is composed of Henry A. Blair, Edward L. Brewster, Joseph Leiter, Robert T. Lincoln, John J. Mitchell, Erskine M. Phelps, A. A. Sprague, Lambert Tree and Samuel Insull.

The output of the Commonwealth Edison Company is generated in two principal stations—the Fisk street and the Harrison street stations. The former has a capacity of about 100,000 kilowatts in ten turbo-generators—four 7,000-kilowatt, and six 12,000-kilowatt; and the latter has

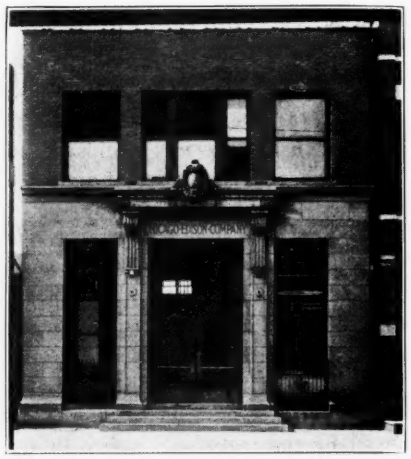


FIG. 4.—WEST LAKE STREET SUBSTATION.

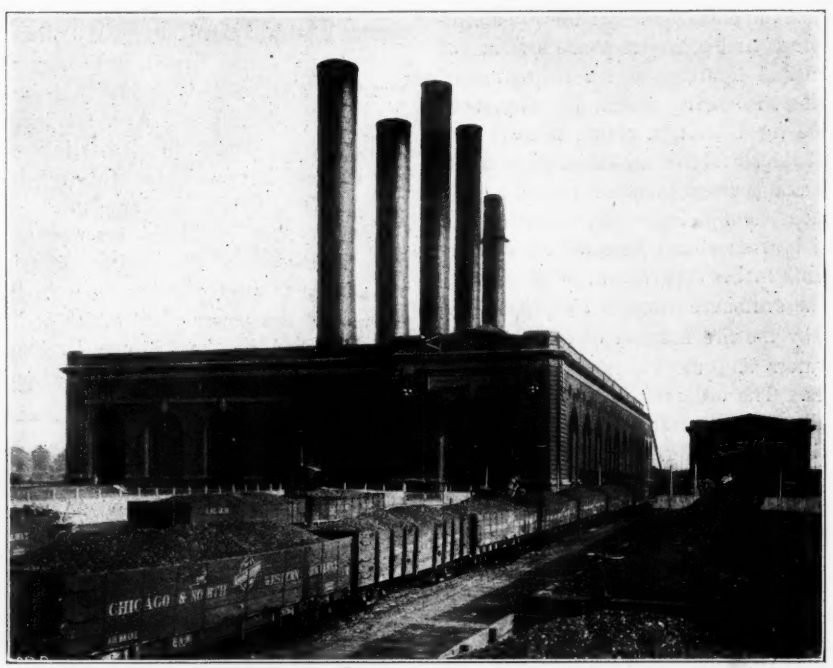


FIG. 3.—EXTERIOR VIEW, FISK STREET STATION.

a capacity of 18,000 kilowatts in engine-driven generators. The twenty-five-cycle, 9,000-volt, three-phase transmission system aggregates about 270 miles, all underground, and distributes to thirty-three general and eleven railway substations. Fig. 2 shows the plan of the stations and substations of the company. Fig. 3 shows the exterior of the Fisk street station. Fig. 6 shows the interior of the Fisk street station, equipped with its Curtis turbine generating units. Figs. 4, 5, 7, and 11 are views of typical substations, and Fig. 8 a view in the White City substation. This station supplies all of the current for the White City, which is one of the most popular amusement resorts in Chicago, and is a rival in illuminating features and attractiveness of the famous

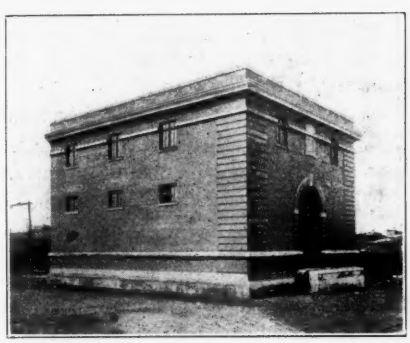


FIG. 5.—WEST TWENTY-SECOND STREET SUBSTATION.

Dreamland and Luna Park resorts at Coney Island, N. Y. The total area

covered by the Commonwealth Edison Company's service is about 100 square miles. Fifteen per cent of this is covered by an Edison three-wire, direct-current, underground system, and the remainder by a four-wire, three-phase, sixty-cycle system, partly overhead. The storage-battery equipment of the company aggregates 16,000 kilowatts at a one-hour rate of discharge.

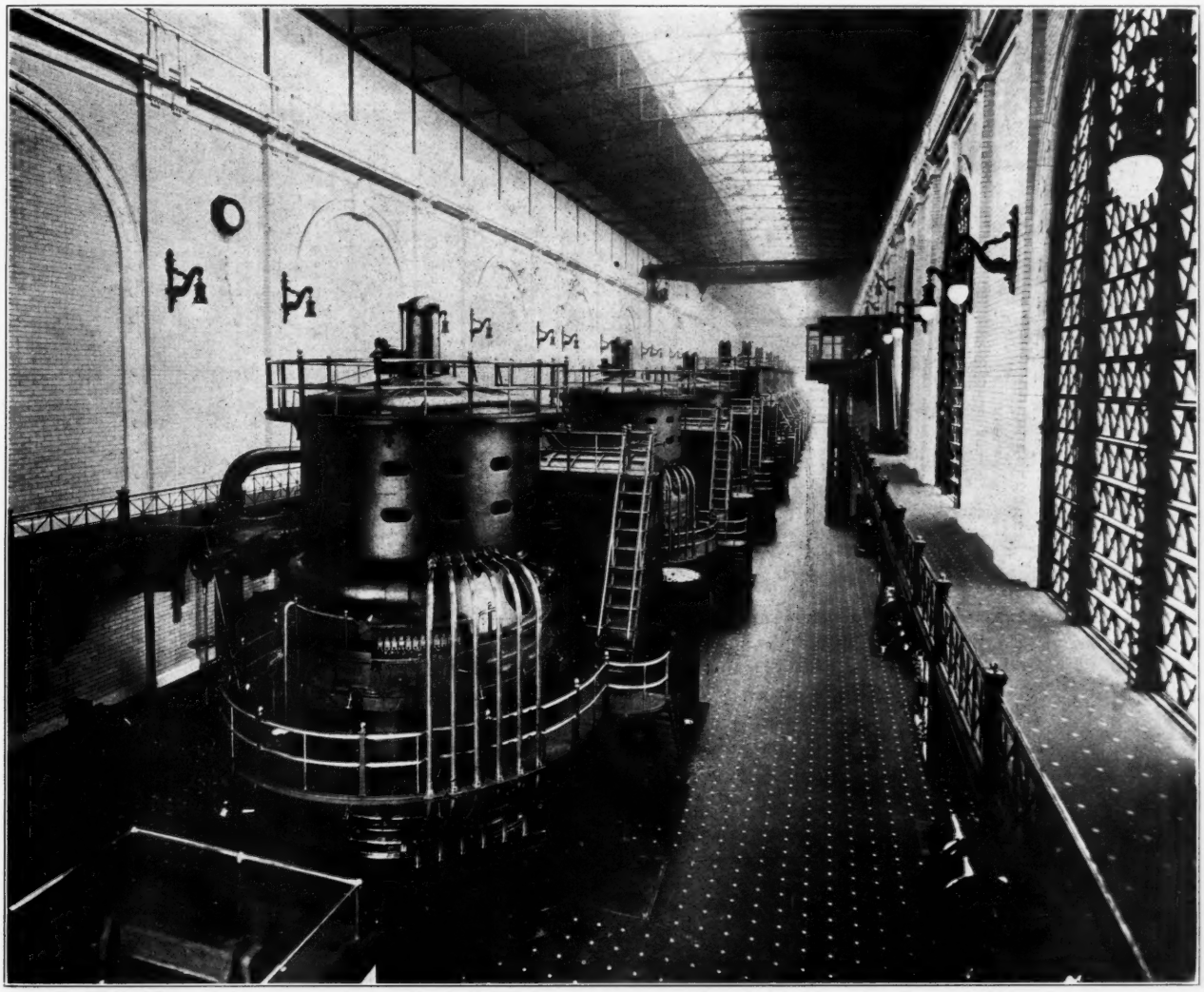


FIG. 6.—INTERIOR OF FISK STREET STATION, SHOWING THE TURBINE ROOM, CONTAINING TEN UNITS.

FIG. 7.—INTERIOR VIEW, MARKET STREET SUBSTATION.

FIG. 8.—INTERIOR VIEW OF THE "WHITE CITY" SUBSTATION.

The Commonwealth Edison Company's system is unique in two respects: It has

the best power-load of any city in the country, and its sign-lighting load is also greater than that of any other city in the country. For the week ended December 7 its total connected lighting load was equal to 2,122,115 sixteen-candle-power equivalents, and its total connected power load was equal to 1,543,973 sixteen-candle-power equivalents, making a total connected commercial load of 3,666,088 sixteen-candle-power equivalents. The company also has a railway load approximating 4,000 kilowatts. It has connected up about 3,500 electric signs, averaging twenty-five sixteen-candle-power lamps to each sign.

One of the interesting pieces of substation apparatus which the company has recently installed is a vertical-shaft rotary converter. This is shown in Fig. 9. This is the first 2,000-kilowatt rotary converter ever put in service. It is a 2,000-kilowatt General Electric machine, and runs at 166 revolutions per minute. The weight of the revolving armature is transmitted either to a roller bearing or an oil-pressure bearing. It is expected that the roller bearing will be the form finally adopted. The armature revolves about a central stationary shaft which is twenty-three inches in diameter and carries on its upper end the interchangeable roller or oil-pressure bearing. The armature is mounted on a sleeve revolving outside of the stationary shaft, the weight of this sleeve and the armature being taken by the bearing at the upper end. The field magnet carries eighteen poles, and is supported on cast-iron pillars resting on a concrete base ring. The rotating armature is kept in alignment by two guide bearings, each fourteen inches long, below the upper bearing. Vertical motor-generator sets have been operated successfully by the company for some time. One of these is shown in Fig. 10.

The company has a standard rate of charging, upon the maximum-demand sys-

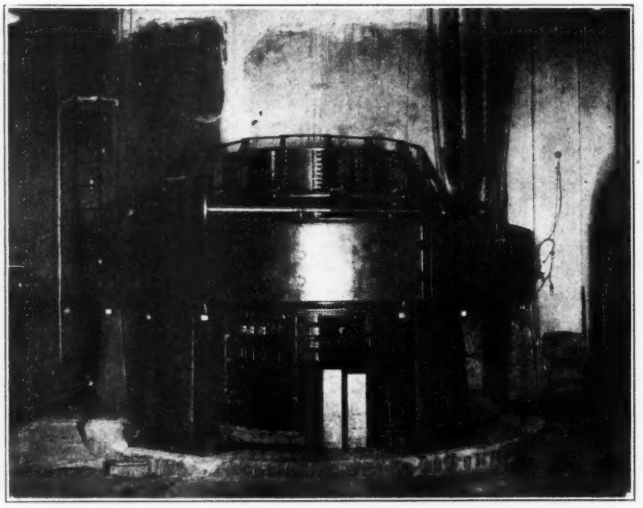


FIG. 9.—THE FIRST 2,000-KILOWATT ROTARY CONVERTER EVER PUT INTO SERVICE.

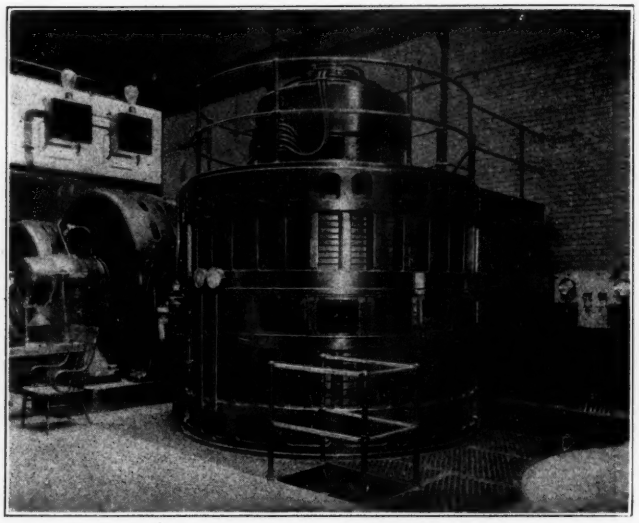


FIG. 10.—A 2,000-KILOWATT VERTICAL MOTOR-GENERATOR SET.

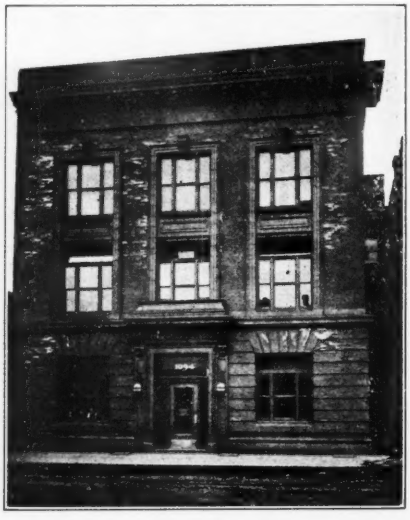


FIG. 11.—WEST MADISON STREET SUBSTATION.

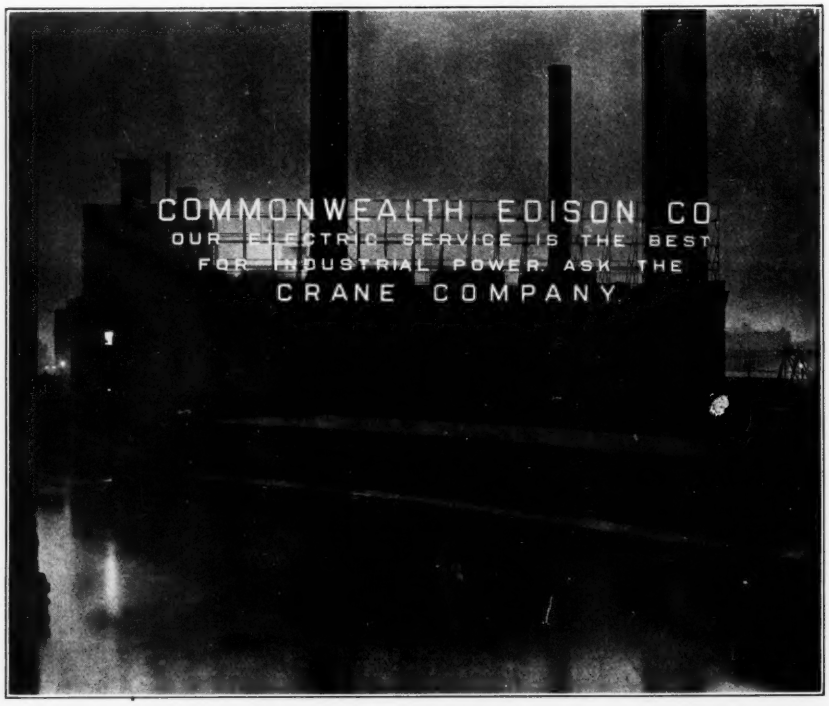


FIG. 12.—ELECTRIC SIGN ON HARRISON STREET STATION CONTAINING 2,007 FOUR-CANDLE-POWER LAMPS, THE SIGN BEING 220 FEET LONG AND FORTY FEET HIGH.

tem. The consumer agrees to pay monthly, within ten days of the date of bills, fifteen cents per kilowatt-hour for all electricity consumed in each month which shall be in excess of thirty hours' use of the maximum number of kilowatts taken at any one time during the month. The consumer pays nine cents per kilowatt-hour for all electricity consumed in excess of thirty hours' use of the maximum number of kilowatts taken at any one time during the month. Wholesale discounts are allowed by the company from the secondary or low-rate portion of the bill whenever the low-rate portion amounts to $100 or more in any one month.

For general power service the company has a standard rate of ten cents per kilowatt-hour for a metered consumption of electricity equivalent to the first thirty hours (or fraction thereof) per month use of the maximum demand; five cents per kilowatt-hour for the next thirty hours, and three cents per kilowatt-hour for the last 660 hours. The company also allows wholesale discounts for all bills, figured as above, and in which the net low-rate portion amounts to over $50 for any one month.

There is also a standard rate for elevator power of ten cents per kilowatt-hour, as measured by the meter or meters installed by the company. This rate, however, is subject to discounts varying according to the monthly consumption. Under 200 kilowatt-hours the cost is ten cents per kilowatt-hour; 200 kilowatt-hours, ten cents a kilowatt-hour, with a discount of fifteen per cent; 300 kilowatt-hours, ten cents a kilowatt-hour, with a discount of twenty-five per cent; ranging up to 2,000 kilowatt-hours at ten cents per kilowatt-hour, with a discount of fifty-five per cent.

The company maintains, of course, its auditing and accounting departments, meter department, inspection department, interior wiring department, supply department, operating department, engineering department and statistical bureau. In addition to these there is the business-getting department, in which are employed ninety staff men and clerks. About sixty-five of these employés solicit light, power and sign contracts on the street every day. The balance of the force is used in collecting information, records of the business, and special work in the office. Most of the men operate from the central office, but there are two district offices from which twenty-two of the men operate directly. These district offices are in charge of superintendents who, in matters pertaining to getting business, report to the general contract agent, E. W. Lloyd. The superintendent for each district also looks after other matters pertaining to other departments of the business in his district.

Quite recently the company has erected an immense electric sign on the roof of the Harrison street station. This contains 2,007 four-candle-power lamps, is 220 feet long and forty feet high. A feature of this advertising service is the use by the company of a reference to some large user of either power or light, the inscription on the lower part of the sign being changed periodically to indicate some new reference.

The Electric Traction Situation.

EVEN since the early days Chicago has been beset with traction problems. The hardy, progressive people making up the majority of the population of this city have always arrogated to themselves the privilege of expecting the best traction facilities that could be reasonably secured. The history of the various companies operating the traction facilities has been one of great effort, receiverships and reorganizations, so that little remains today of the original organizations which gave Chicago its first public utilities in the form of street-car service. In 1900 we saw the Citizens' Street Railway Company asking the city council for a charter including a blanket ordinance covering about 400 miles of track, providing for the purchasing of the rails then laid at a rate not exceeding $25,000 per mile. This company held out as an inducement to the municipality a flat three-cent fare. This charter was asked for in October, 1900. The street railway companies themselves were at war with the city over the interpretation of the ninety-nine-year clauses in their franchises. These ninety-nine-year grants were given to the companies by the legislature, and the city, interpreting the terms of certain combinations, held that the franchises expired at a considerably earlier date. Under this holding, the year 1903 was prolific in the expiration of franchises which the companies believed had many more years to run. The litigation, carried to the Supreme Court, resulted finally in favor of the city.

BION J. ARNOLD,
Chairman and Chief Engineer, Board of Supervising Engineers, Chicago Traction Rehabilitation.

The several mayors of Chicago have been elected upon platforms bearing directly upon the street railway situation. Former Mayor Dunne was absolutely pledged to immediate municipal ownership, and under his régime several plans were brought to life. Later elections, however, pointed to the fact that the people were not ready for immediate municipal ownership. The franchise situation has now been cleared up as the result of ordinances passed by the city council on February 11, 1907. F. A. Busse was chosen mayor on a platform which included the settlement of the existing transportation problem on the basis of an agreement with the companies insuring the rapid rehabilitation of the lines. This election took place on April 2, 1907.

The present solution of the traction problem had its inception in the ordinance passed by the city council on May 26, 1902, authorizing the execution of a contract for expert services. In pursuance of this authorization the mayor, Carter H. Harrison, and the city controller, L. E. McGann, executed a contract for the city with Bion J. Arnold, July 19, 1902, to render to the local transportation committee of the city council such services as might be needed for a comprehensive report upon the cost of operations and earnings of the railroad companies, a valuation of the plants, an estimate of the cost of production of a single new system adequate to serve the public, and submit designs for future rehabilitation and extension. On November 19, 1902, Mr. Arnold submitted a voluminous report covering these points.

Many obstacles appeared, and the matter rested, stirred now and then by some more or less violent agitation, when it again became a political issue, and, following his election to office on a municipal ownership platform, Mayor Edward F. Dunne, laid out a plan for gradual municipalization in a letter dated April 27, 1906, to Alderman Charles Werno,

chairman of the committee on local transportation. On December 10, 1906, the Traction Valuation Commission, composed of Bion J. Arnold, Mortimer E. Cooley and A. B. du Pont, with George Weston, acting as engineer in charge, which had in the meantime been appointed, rendered its report to the committee on local transportation, fixing the values of the tangible and intangible properties of the Chicago City Railway Company and the Union Traction Company. Upon the basis of this report and the "Werno" letter, the present ordinances have been formed.

The principal provisions of the ordinances covering this work, passed by the council and ratified by the people at the election on the second of April, and accepted by the Chicago City Railway Company on April 15, 1907, are as follows: The city and the companies, respectively, agree that the value of the present tangible and intangible properties of the Union Traction system is $29,000,000, and of the Chicago City Railway system, $21,000,000. The companies agree that they will proceed at once to rehabilitate and reequip their entire street railway systems and put them in first-class condition, in full compliance with the specifications for such work, and under the supervision of a board of supervising engineers created under these ordinances. The board of supervising engineers consists of Harvey B. Fleming, acting for the Chicago City Railway Company; Charles V. Weston, acting for the city of Chicago, and John Z. Murphy, acting for the receivers of the Union Traction Company, which has not, up to the present time, accepted its franchise. Bion J. Arnold was selected as chairman of the board and chief engineer of the work of rehabilitation, George Weston acting as assistant chief engineer.

The surface lines serving the city of Chicago are either owned or operated by eight companies, *viz.:* the Chicago City Railway Company, the Chicago Union Traction Company, the Chicago General Railway Company, the Chicago Consolidated Traction Company, the South Chicago City Railway Company, the Calumet Electric Street Railway Company, the Chicago Electric Traction Company and the Suburban Railway Company. The mileage of the three former companies is entirely within the city limits. The mileage of the remaining five companies is partly within the city limits and partly in adjoining territory. There are four companies operating elevated railroads, all of which operate to the business centre and around one common loop controlled by a fifth company. The Chicago City Railway Company serves that portion of the south division contiguous to the business centre, but has no affiliation with or control of the companies serving the outlying southerly territory. The Chicago Union Traction Company, by virtue of leases, controlled the operation of the lines of the North Chicago Street Railroad Company and the West Chicago Street Railroad Company and their subsidiary companies, the Chicago Passenger Railway Company, the Chicago West Division Railway and the North Chicago City Railway Company. The west and north divisions are served by these companies, except where the lines of the Chicago Consolidated Traction Company are built through the territory contiguous to the business centre and where operating privileges are exchanged between the Union and Consolidated companies.

The Chicago Union Traction Company was incorporated on June 3, 1899. On April 22, 1903, the company passed into the hands of receivers. Efforts have been made to bring about an agreement between the bondholders of this company and its affiliated companies, so that a new company, the Chicago Railways Company, incorporated on October 29, 1903, might act as a trustee and make a franchise agreement with the city regarding the operation of the street railways on the north and west sides of Chicago. The latest development in this direction has been the order of a sale of these properties, under a decree of foreclosure, by Judge Peter S. Grosscup, sitting in the United States Circuit Court on December 26. The sale is to take place at noon on January 25, under the direction of H. W. Bishop, who has been appointed a special master commissioned by the Court. An order has also been entered instructing the receivers of the property to execute to the Chicago Railways Company a lease of all the lines of street railways operated by it. This lease is to expire on February 2, 1927. It is taken for granted that the Railways Company will be the only bidder for the property at the sale, and the order of the Court is, in effect, merely a form of a plan worked out for the rehabilitation of the Union Traction Company by the Railways Company. Judge Grosscup, in affirming the decree, said: "What the entry of these orders means is that 2,000,000 people have at last come to an understanding with some 20,000 people, constituting the creditors, bondholders and stockholders of the old Union Traction system, whereby, as nearly as human judgment can reach such results, the 2,000,000 people get what is due them as a community, the 20,000 get what is due them as a body, and each of the 20,000 gets what is due him as an individual."

Following the acceptance, on February 1, of the ordinance by which the Chicago Railways Company will come into possession of the traction properties affected by this decree, the Railways Company will immediately begin rehabilitation of the lines at a cost of $12,000,000, and within three years must have rebuilt at least ninety miles of single track and have in operation at least 1,200 new cars.

The ordinances issued to the two companies provide that the city or any other company authorized by it has the right to purchase the entire property of the two systems, or either of them, upon the payment of the agreed price of the present property of each company, respectively, and the cost of rehabilitation and extensions, including a fair allowance for construction, profit and brokerage. If the street railways are to be acquired for operation by a private corporation, for its own profit, the purchase price is to be increased twenty per cent.

The companies are limited, during their operation, to an interest return of five per cent upon the agreed value of their properties plus the cost of rehabilitation and extensions. The net profits from the operation of the street railways are to be divided between the city and the companies in the ratio of fifty-five per cent to the city and forty-five per cent to the companies.

Of the gross receipts, six per cent must be set aside for maintenance and repairs. There must also be set aside an additional and separate fund of eight per cent of the gross receipts to cover renewals and depreciation. Whatever portion of the two funds above mentioned is not actually devoted to the purposes specified remains in the funds and passes to the city or its licensee upon purchase.

Transfers and through routes, by means of which passengers may ride over all connecting lines within the city limits covered by the Chicago Union Traction system, the Chicago City Railway Company, the Chicago Consolidated system and the Chicago General Railway system for a single fare in any one general direction, are provided. Extensions of existing lines are specifically provided for.

The companies agree, under the ordinances, upon demand of the city, and at the city's option, to furnish funds to the amount of $5,000,000 for the construction of a central subway to be built and owned

by the city, the plans for which are to be approved by the board of supervising engineers. The companies also agree to furnish to the city the funds for the construction of extensions to this subway on the terms stated in the ordinances. The Chicago Railways Company agrees to lower and reconstruct the tunnels under the Chicago river, at Washington, La Salle and Van Buren streets. The city is also authorized to require the installation of the underground trolley system in place of overhead wires. The capacity of the surface lines within the loop district will be largely increased by the through routes and rearrangement of the existing terminals.

Subject to the approval, and according to forms provided by the city comptroller, the books and accounts of the companies are to be ready for the inspection of the city's accountants at all times. The companies are required to make sworn statements annually to the city, and there is also a provision for an annual audit of their books by public accountants.

Due to the immense rehabilitation that is now planned, it will be necessary only to refer briefly to the equipment of the various companies. The Union Traction Company operates about 307 miles of electric track and forty-eight miles of cable track. Power plants are located at 430 North Clark street, at Van Buren and Jefferson streets, at Western avenue and Washington Boulevard, and at Milwaukee avenue and Cleaver street. The company has large repair shops at Washington Boulevard and Fortieth avenue.

The Chicago City Railway Company operates 242 miles of electric track and has power plants located at Fifty-second street and Wabash avenue, Fifty-fifth street and Cottage Grove avenue, Fifty-second and State streets, Forty-ninth street and Oakley avenue, Twenty-first and State streets, Twenty-first and Dearborn streets, with repair shops at Seventy-eighth street and Vincennes avenue.

The Calumet Electric Street Railway Company operates thirty-eight miles of main line and forty-two miles of electric track, with a power station located at Ninety-third street and Drexel avenue.

The Chicago & Southern Traction Company operates 132 miles of electric track, with power station at Blue Island and Eighty-eighth street, and repair shops at Eighty-eighth street and Vincennes road.

The Chicago Electric Traction Company operates thirty-one miles of electric track and also has its power station and repair shops at Eighty-eighth street and Vincennes road.

The Southern Street Railway Company operates thirty miles of electric track, with a power station and repair shop at Thirtieth street and Kedzie avenue.

The elevated railroad systems of Chicago include the South Side Elevated Railroad Company, operating eighteen miles of elevated electric track, with a power station at Fortieth and State streets; the Chicago & Oak Park Elevated Railway Company, operating six miles of elevated electric and three and one-half miles of surface electric track; the Metropolitan West Side Elevated Railway Company, operating fifty-one miles of elevated electric track, with a power station at 139 Throop street, and repair shops at 146 Throop street. The Northwestern Elevated Railroad Company operates twenty-five miles of elevated track, with a power station at Southport and Fullerton avenues.

Running out of Chicago, the Aurora, Elgin & Chicago Railroad Company operates electric railways between Chicago, Elgin, Aurora, Geneva, Wheaton and Batavia, and local car lines in Elgin and Aurora. In all, the company owns 158 miles of single track. Its entrance into Chicago is over the Metropolitan Elevated road. The property is largely on private right of way. The general power station is at Batavia, Ill., and repair shops are located at Wheaton, Aurora and Elgin.

The Telephone Situation.

FOR some years the matter of a telephone franchise for the city of Chicago was one of grave concern and considerable controversy. On November 6, 1907, the city council passed an ordinance granting a new franchise to the Chicago Telephone Company to operate for twenty-five years. Mayor Busse signed the ordinance on November 11, and the franchise went into effect upon acceptance by the company. This franchise was passed after one of the most thorough investigations ever preceding the disposal of a public utility measure.

For several years the Council Committee on Gas, Oil and Electric Light had been conducting negotiations looking to the drafting of an adequate franchise ordinance for the furnishing of telephone service in Chicago. Several organizations and companies made bids for the franchise, presenting measures which embodied the conditions under which they proposed to serve the subscribers. The franchise held at that time by the Chicago Telephone Company would have expired during the present year. This company, because of its extensive and modern plant, was certainly the most logical successor

ANGUS S. HIBBARD.
Vice-President and General Manager, Chicago Telephone Company.

to the field. The negotiations, however, were con ucted purely on the theory of securing the lowest possible rates commensurate with good service. The principal contender with the old company was the Manufacturers' Telephone Company, an organization composed of members of the Illinois Manufacturers' Association. Toward the close of the negotiations a plan was also suggested whereby the franchise of the Illinois Tunnel Company should be broadened so that its automatic system now in operation in the centre loop district might be extended to cover the entire city.

An exhaustive study of the situation was made by the council committee, and a great many meetings were held, where hearings were given to all interested. Numerous inspection trips were made to various other cities, and the council committee also had the expert advice of D. C. Jackson, W. H. Crumb and G. W. Wilder.

A great amount of work has been put upon the company in the classes of service required by the ordinance. All of the ten-party line telephones, of which there are about 40,000, are to be changed to four-party lines for residences and two-party lines for places of business. Several other classes of service are also to be changed.

The rates offered are lower than heretofore, and will undoubtedly result in an increase in the number of subscribers, which, for the city, is now something over 150,000 telephones. It is fortunate for the company that it is able to meet the situation by a well-established city plant

comprising twenty-two exchanges, with modern equipment and extended subway, underground cable and distribution plant. Additions must be made to this to take care of the changes and new business offered, but the foundations have been well laid, and the work will undoubtedly be done as rapidly as will be found consistent with the maintenance of the high-class telephone service which has been the standard of the Chicago Telephone Company.

THE CHICAGO SUBWAY SYSTEM.

THE Chicago subway system is under construction by the Illinois Tunnel Company. The company was incorporated on October 29, 1903, in Illinois, to do a general telephone, freight transfer, steam or electric power, heating and illuminating business. The company's steam railroad terminal lines connect the freight yards of twenty-six trunk-line railroads with merchant warehouses. The company also operates forty-five miles of narrow-gauge electric tunnel railroad for the transfer of freight from various steam railroads to the business district of Chicago. It is proposed to further develop and extend the tunnel system. The entire tunnel system was put in operation on August 15, 1906, but freight was not carried to any great extent until November 1, 1906.

The Chicago Subway Company, incorporated November 16, 1904, in New Jersey, holds the entire capital stock of the Illinois Tunnel Company, the Illinois Telephone and Construction Company and the Chicago Warehouse and Terminal Company.

The Illinois Telephone and Construction Company was incorporated August 1, 1899, in Illinois. This company formerly owned a telephone exchange in the business section of Chicago, controlling an automatic switchboard for 10,000 main-line telephones. On January 1, 1907, this company sold its entire telephone equipment to a syndicate representing the Independent Telephone Company. The purchaser agreed to increase the system to 20,000 telephones in 1907, and to add 10,000 yearly until 100,000 were in use; also to pay the Illinois Telephone and Construction Company an annual rental of $5 for each telephone in service.

The total length of tunnel in which permanent track has been laid covers 219,331 feet. The permanent trolley system has been extended to a length of 209,488 feet. A drainage system covering 212,281 feet has been installed, as has also a permanent lighting system covering 210,000 feet. The narrow-gauge railway is served by electric locomotives, current being taken from overhead conductors.

The subway serves the United States Post-office Building from Jackson Boulevard to Adams street. The mail is thrown down chutes from the mailing platform to the platform of the subway, where the pouches are placed in the cars of the tunnel company and sent to their destination.

Electrical Manufacturing Interests in Chicago.

CHICAGO is truly representative of the electrical industry. Centred in the business district are the offices of nearly every prominent electrical manufacturing concern in the United States. The large corporations both East and West find a most profitable market for every conceivable electrical device, and the rapid development of the demand for large and small apparatus has increased the importance of Chicago as a centre for the gathering of representatives from all parts of the country.

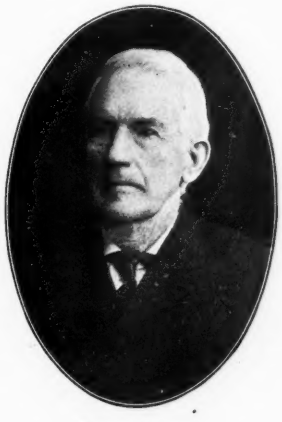
Of course, the Western Electric Company, with its mammoth warehouses and manufacturing plants in the city and its immense factories at Hawthorne, Ill., is easily the leading electrical manufacturing concern in this locality. The company maintains extensive offices at 259 South Clinton street. The Hawthorne shops consist of six principal groups of buildings. The office, foundry, forge shops and machine shops devoted to the manufacture of direct and alternating-current motors and generators are located on the west side of a belt railway. The cable and rubber plants, devoted to the manufacture of telephone and power cables, and rubber in the various forms in which it is used for telephone service, are located on the east side of the railway. In addition to these buildings there are a gas plant, water tower, power plant and two crematory buildings. The entire plant covers approximately one million square feet of floor space, and is located on a tract of land 110 acres in extent. The Chicago Terminal and Manufacturers' Junction Railway tracks pass through the property, and connection is made by an elevated spur track to the main line of the Chicago, Burlington & Quincy. The personnel of the company is as follows: president, Enos M. Barton; vice-president, H. B. Thayer; secretary, C. G. DuBois; assistant secretary, R. H. Gregory; treasurer, F. V. Bennis.

The Allis-Chalmers Company maintains a large office in Chicago, but has its principal works located at West Allis, in the suburbs of Milwaukee, Wis. As a matter of fact, the manufacturing facilities of the Allis-Chalmers Company are distributed among several large plants located in the principal industrial sections of the country. The West Allis works cover 110 acres of land. The yards about the works are covered with a network of railroad tracks, supplemented by an extensive system of cranes and telphers. A power-house with a capacity of 10,000 horse-power in turbines, gas engines and reciprocating engines supplies power for operating the machine tools, and provides light, heat and ventilation. The melting capacity of the Allis-Chalmers foundry is approximately 520 tons daily. Some of the castings recently made for gas-engine and blower-engine service have reached record proportions, and have taxed the limit of flat cars and railroad service to move them to their destinations. The company's electrical works are located principally at Norwood, just out of Cincinnati, Ohio, but a large amount of electrical machinery is now being constructed at West Allis. The plant of the company is extremely busy just at this time, and has made record shipments for the past six months. The personnel of the company is as follows: president, W. H. Whiteside; first vice-president, L. F. Bower; second vice-president and treasurer, Henry Woodland; third vice-president and secretary, W. W. Nichols.

The Cutler-Hammer Manufacturing Company maintains a large office in Chicago, with factories located at Milwaukee, Wis. This company is one of the leading manufacturers of controlling apparatus, and its engineering corps has become recognized as a leading authority on the subject of electrical control. The company makes more than 2,500 types and sizes of electrical controlling devices, including controllers for pumps, elevators, printing presses and machine tools. An important branch of the business is the manufacture of theatre dimmers, apparatus of this nature made by the Cutler-Hammer Manufacturing Company having been installed in theatres in every part of the world. The general officers of the company are: president, Frank R. Bacon; vice-president, H. H. Cutler; treasurer, F. R. Pierce; secretary, R. H. Mansfield; general manager, A. W. Berresford. The Cutler-Hammer Clutch Manufacturing Company, whose apparatus is manufactured at this plant, makes a very popular form of electromagnetic clutch which has found wide use in

factories and machine tools, and has recently brought out a line of lifting magnets which has already gained wide use for handling materials in machine shops, foundries, and for loading and unloading metal forms from car sidings and warehouses. The company also makes the electrical apparatus for the axle-lighting system of the Bliss Car Heating and Lighting Company.

The Ajax Line Material Company occupies a deep double building at 12 and 14 South Jefferson street. Although but two years old, the company has gained an unusual foothold among electric-light plants and electrical contractors, due chiefly to the up-to-dateness of its product. The company makes a specialty of line material, most of the devices being the invention of Albert Scheible, president of the company. Mr. Scheible's aptitude for this class of work was well demonstrated during his previous ten years' con-



JOHN ALLEN,
President, L. B. Allen Company.

nection as secretary and treasurer of the George Cutter Company. Associated with him are John F. Turner, recruited from the treasurership of the Sanitary Feather Company; Durl P. Ruger, a young mechanic who combines fine training with an unusual ability for devising special tools; and George L. Cragg, the patent attorney, whose successful handling of the Duncan meter cases has attracted much attention. The company's original paid-up capital of $12,500 has already been doubled to take care of its growing trade, and branch offices have been established at New York and St. Louis.

The L. B. Allen Company, Incorporated, was established under the laws of the state of Illinois on January 3, 1899. The personnel has remained the same since incorporation. John D. Allen is president; Stuart S. Crippen, secretary and general manager, and C. A. Crippen, treasurer. The company was originated for the manufacture and sale of electrical supplies, but has confined itself to the manufacture and sale of electrochemical products, chiefly soldering sticks, paste and salts. The company makes a specialty of "Sun" and "Samson" soldering sticks, Allen commutator lubricant, liquid flux, metal polishes and resin-core solder. In 1905 the business showed an increase of twenty-five per cent over that of 1904. In 1906 the business increase was a fraction over thirty-two per cent. In 1907 the increase was forty per cent over that of 1906. The records for 1907 have not been completed, but one department showed an increase of practically 300 per cent in the last three years and of 150 per cent over 1906. The Allen products have been on the market for about fourteen years, and enjoy the favor of the most careful and discriminating users, both large and small. The company has established branch offices in New York, St. Louis, Alameda, Cal., and Montreal, Canada.

Among the big engineering companies native to Chicago, the Arnold Company stands out prominently. The company's office is located at 181 La Salle street. In the unparalleled activity in engineering work for 1907, the Arnold Company has taken a large share. The work of the company began with the efforts of Bion J. Arnold, president of the company, as consulting engineer. The scope of work has constantly increased during the past few years, and in this time Mr. Arnold has built up an organization with George A. Damon as managing engineer, and has carried on this constantly increasing work. The other officers of the company are: W. L. Arnold, vice-president, and R. G. Arnold, secretary and treasurer. Starting with the design of power plants, the field of work has been extended to include designs of electric railways and industrial plants. Later, contracts for the construction of the work designed by the company were taken. In the last two or three years a large amount of railway shop design work has passed through the office, together with the design and construction of hydroelectric plants, interurban roads and other industrial properties. The systematizing of methods of production and the efficient distribution of materials entering into the manufactured product are principles which are constantly being applied in the most progressive factories. The Arnold Company is applying this system in its work as an engineer-constructor in the creation of the various properties with the construction of which it has been connected. The method of procedure in which the company has attained its best work is at the same time the most logical, the most economical and the most expeditious to be used in the construction of properties. It comprises first of all a study of the conditions under which the property is to operate and the requirements which it is to fulfil, this study being preparatory to the design of the property. After the details of construction have been worked out in consultation with the clients the work of construction progresses rapidly, all the varying lines of work required in the construction of any property being handled entirely by the one organization. The rapidly increasing work of the Arnold Company as engineer-constructor is evidence of the increasing feeling among those building large properties that their best interests can be served by turning over the design and construction of these properties to a skilled organization.

FRANK S. BEARDSLEE,
President, Beardslee Chandelier Manufacturing Company.

The Automatic Electric Company has a mammoth factory at Morgan and Van Buren streets, for the production of the most widely used and successful automatic telephone apparatus yet devised. This system has been adopted for extensive use in large and small stations throughout the country, and during the year just closed equipments running into many millions of dollars have been constructed. During the year the litigation with the Strowger interests was ended by the Automatic Company's taking control of these interests.

The manufacture of electric and combination features is one of the leading industries of Chicago. One of the foremost manufacturers in this line is the Beardslee Chandelier Manufacturing Company, located at 176-180 South Clinton street. The company manufactures only for the

trade, and its business extends to all parts of the United States, as well as to a considerable export trade. The officers of the company are: Frank S. Beardslee, president and manager; George M. Beardslee, treasurer and in charge of the sales department; Robert Schrumpf, secretary and in charge of the designing department, and Henry Schob, general superintendent of works.

H. M. Byllesby,
President, H. M. Byllesby & Company.

The Benjamin Electric Manufacturing Company, located at 42 West Jackson Boulevard, has made a reputation in a field which it has created and practically made its own. This company is the manufacturer of a line of wireless clusters and lighting specialties which has been received with great favor throughout the electrical industry. The company has recently placed on the market several new forms of clusters and lighting specialties which mark great advances in these devices and fill wants which have long been felt in the trade.

The Bryan-Marsh Company is one of the large manufacturers of incandescent lamps with main offices in Chicago, in the Fisher Building, under the management of E. H. Haughton.

H. M. Byllesby & Company maintains one of the largest engineering organizations in Chicago, with headquarters in the American Trust Building. The firm was incorporated on January 1, 1902. The field of operation of the company is very extensive, embracing not only the reorganization, financing, operating and engineering of public utility corporations, but the company also has a bond department for the disposition of securities. The company has an operating department, legal department, auditing department, with a corps of accountants, and a well-organized engineering department. The engineering department has been connected in a consulting, construction and designing capacity in all kinds of engineering enterprises throughout the United States and Canada. This company does not limit itself to electrical and gas utilities, but has financed, constructed, and in many cases acted in a consulting capacity for outside financial interests, electric-light plants, gas plants, interurban railways, local railways, water-power, irrigation and drainage systems. It has also recently entered, with success, the natural-gas field, having developed very large gas territories and designed the natural-gas distributing systems. It is the aim of this organization to have the men connected with it of the broadest and maturest experience in the line of utility enterprise. The chief officers of the organization are: H. M. Byllesby, president; Arthur S. Huey, vice-president, in charge of operation; Otto E. Osthoff, vice-president and chief engineer, in charge of engineering department; J. J. O'Brien, treasurer and general auditor, in charge of auditing department, and James S. Cummins, vice-president and general counsel, in charge of legal department. Permanent branch offices have been established at Mobile, Ala.; Alameda, San Diego, Cal., and Oklahoma City, Okla.

Arthur S. Huey,
Vice-President, H. M. Byllesby & Company.

George A. McKinlock,
President, Central Electric Company.

Prominent among the electrical supply houses is the Central Electric Company, with warehouses at 264-270 Fifth avenue.

Otto E. Osthoff,
Vice-President and Chief Engineer, H. M. Byllesby & Company.

The company was incorporated in 1887, and has devoted twenty-two years exclusively to the jobbing and merchandizing of electrical supplies. During all this time the company has been under the same management, and is decidedly an exception in this respect. It has been the general western agent for "Okonite" wires and cables, and has added sales agencies for the D & W Fuse Company, the Columbia Incandescent Lamp Company, G-I. are lamps and Pittsburg transformers, all of which are well-known specialties. Few men in the electrical industry are better known and held in greater affection than George A. McKinlock, president, and Charles E. Brown, secretary. S. E. Kennedy is auditor of the company, and has charge of all credits, also acting as manager of the entire office. Mr. Kennedy has been with the Central Electric Company for fourteen years, and is well known by electrical men throughout the Middle West. George H. Ellis is general superintendent, and is also an old-time electrical man, having begun with the General Electric Company eighteen or twenty years ago. F. R. Bryant is sales manager, and has charge of the advertising. He has been with the company for four years, and is one of the popular young men of the West. Allen S. Pearl is manager of the specialty department, and has been connected with the company for twelve years. R. K. Fast has, within the past two years, taken charge of the electric-

railway department, and is building up a flourishing department in pushing the sale of overhead railway material and specialties, such as "Dielectric" compound and "Deltabeston" magnet wire for railway, field and armature work. Henry G. Hafner has supervision of the purchasing and tracing departments of the company. J. F. McClelland is manager of the fixture department, and also of the retail store. W. G. Ney is manager of the claim department, having supervision of all claims and overseeing the payment of all accounts.

CHARLES E. BROWN,
Secretary, Central Electric Company.

H. G. HAFNER,
Purchasing Agent, Central Electric Company.

S. E. KENNEDY,
Auditor, Central Electric Company.

The Chicago Fuse Wire and Manufacturing Company is located at 170 South Clinton street, and manufactures the well-known "Union" outlet and switch boxes and "Union" enclosed fuses and blocks, fuse wire, links, etc. The company has made steady progress, especially during the last four years. All of its material and boxes are approved by the Underwriters' laboratories. The company also makes a line of round and square conduit boxes and covers which has not yet been catalogued. The president and treasurer of the company is Arthur D. Dana, and associated with him in the New York office, as principal salesman, is Samuel W. Craymer. The western business is handled by the secretary and treasurer, William W. Merrill, the principal salesman being Arthur Merrill, formerly with Pass & Seymour. The bulk of the company's manufacture is done in Chicago. Clarence T. McDonald is the company's electrical engineer.

Frank B. Cook maintains a large establishment at 240-244 West Lake street for the manufacture of iron distributing frames, switchboard protectors, telephone protectors, pole-cable terminals, lightning arresters, heat coils and line fuses, test connectors, wire joints, guy clamps and anchors. Mr. Cook is one of the very well-known men in this line of manufacture, and is always a familiar figure at the electrical shows and telephone conventions.

The Crocker-Wheeler Company maintains handsome offices in the Old Colony Building, under the management of Julian Roe. The western office was established in July, 1897, and the territory assigned covers the western part of Ohio, Michigan, Indiana, Illinois, Wisconsin, Iowa, Nebraska, Minnesota, North and South Dakota. The organization consists of an electrical engineer, several sales engineers and a force of erecting engineers, as all installation work is done from this office. The company carries in stock in Chicago several hundred standard motors in sizes up to 150 horse-power, for immediate delivery. It reports an excellent business this season and a continued substantial increase in business booked since 1897. Mr. Roe has been associated with the Crocker-Wheeler Company since the fall of 1893, first for several months as erector and testing man, also as a salesman at the Philadelphia office. From May, 1894, until July, 1897, he was employed as salesman by Sargent & Lundy, at that time western agent for the Crocker-Wheeler Company. From July, 1897, to January 1, 1900, he was a salesman for the Crocker-Wheeler Company at the Chicago office, and since January, 1900, has been manager of the Chicago office of the company. Crocker-Wheeler apparatus is being used in the most prominent manufacturing and mercantile establishments in Chicago, and the company is furnishing the large alternators for the Lockport power plant of the Chicago Sanitary Drainage Canal.

JULIAN ROE,
Western Manager, Crocker-Wheeler Company.

The Electric Service Supplies Company operates its Porter & Berg department in Chicago. The office is located in the Plymouth Building, where the entire second floor is occupied as offices. There is also a four-story building and basement used as a warehouse, at 57 Plymouth place, where a large and well-assorted stock of electric railway and mine supplies is carried. On January 1, 1906, the businesses of the Mayer & Englund Company, of Philadelphia; Porter & Berg, Chicago; the Garton-Daniels Company and Electrical Devices Company, of Keokuk, Iowa, were consolidated under the name of the Electric Service Supplies Company. All four companies were well known to the electrical trade, and each was strong and representative in its particular field. As a result of this consolidation the new company was enabled to increase its warehouse facilities, as well as strengthen its sales department. For the purpose of better serving its customers, the company established warehouses and sales offices in Philadelphia, Chicago, Pittsburg, St. Louis and Atlanta, and district sales offices and agencies in New York, Kansas City, Minneapolis, Los Angeles and San Francisco. The manufacturing departments

of the company are located in Philadelphia and Keokuk. The management of the Chicago department is in the hands of J. W. Porter, first vice-president, and Max A. Berg, secretary of the company. Both Mr. Porter and Mr. Berg are well known throughout the railway field, especially in Chicago and in the western section. The firm of Porter & Berg started in a small way in 1899, and as a result of progressive and dependable methods, has been recognized as a leader and has enjoyed the best electric railway and mine supply business in the territory which it covers.

A. L. KUEHMSTED,
President, Gregory Electric Company.

A. O. KUEHMSTED,
Vice-President, Gregory Electric Company.

G. C. BESOLD,
Secretary, Gregory Electric Company.

Engaged in the manufacture of ferro-alloys and other electrometallurgical products is the Electrometallurgical Company, located at 157 Michigan avenue. This company is identified with interests controlling the Union Carbide Company, which manufactures the calcium carbide used and sold throughout the United States. The company also manufactures ferro-alloys, primarily high-grade electric furnace ferro-silicon, ferro-chromium, including low-carbon ferro-chromium, ferro-vanadium, etc. The works are established at Kanawha Falls, W. Va., and at Niagara Falls, N. Y. Offices are maintained in New York city and Philadelphia. The company owns or controls fundamental patents covering the production of high-grade electric furnace ferro-silicon, together with broad patents covering processes and apparatus used in the manufacture of ferro-silicon, ferro-chromium and other ferro-alloys.

The Farr Telephone and Construction Supply Company manufactures telephones, switchboards and electrical supplies, and the D & L line of telegraph instruments and thermo-flashers. The company is located at 118 and 120 West Jackson Boulevard, and was organized and incorporated in 1895. In October, 1907, the company was reorganized, at which time A. D. Gibbs was elected president; S. A. Dinsmore, vice-president and general manager; George E. Lawton, secretary and treasurer. Mr. Dinsmore is probably better known to the telephone field than any other of the personnel of the company, being one of the pioneers in the independent telephone field. He has been connected for the past fourteen years as engineer and manager of the telephone department of the Electric Appliance Company, of Chicago.

The W. R. Garton Company is located at 118-132 West Jackson Boulevard. The company was organized in May, 1898, by W. R. Garton and Ray P. Lee, and was incorporated in November, 1899. Mr. Garton was president and treasurer, and Mr. Lee secretary of the company since its incorporation until December 1, 1907, when Mr. Garton retired to become associated with the Lord Electric Company, Mr. Lee succeeding him as president and treasurer. The company has specialized from its inception in street railway supplies. Originally it acted in the capacity of manufacturers' agent, covering an exceptionally broad line of specialties which very soon made a name for it in the railway field. Early in its business career its orders began to cover the general supply line, so that for some years past it has enjoyed the distinction of being one of the largest railway supply houses in the West. It has continued its agencies, and for some years past it has been specializing in the mining supply field, and has a most extensive trade in this branch of electrical industry. While the company's trade covers particularly the central western states, it does business in all parts of the country and Canada, and has some European and Mexican trade.

P. ALBERT POPPENHUSEN,
President, Green Engineering Company.

The General Electric Company maintains an extensive office in the Monadnock Building, under the management of B. E. Sunny, vice-president and western manager.

The Gregory Electric Company, with offices, warehouses and works at Sixteenth and Lincoln streets, makes a specialty of electrical machinery, steam, gas and gasolene engines, which are brought into its works at Chicago, completely overhauled and sold again at a reduction from the price of new machinery. The company's present works were occupied on May 1, 1906. They are equipped for handling heavy machinery, and a switch track of the Chicago, Burlington & Quincy Railway runs into them. The Gregory Electric Company is one of the largest institutions in the country making a specialty of second-hand electrical apparatus. The officers of the company are: A. L. Kuehmsted, president and general manager; A. O. Kuehmsted, vice-president and manager of sales; G. C. Besold, secretary; J. D. Zook, general superintendent; J. A. Vincent, superintendent of works.

The Green Engineering Company, with offices in the Commercial National Bank Building, Chicago, Ill., manufactures the Green traveling link grate. This is an

automatic furnace which is in very wide use throughout the country, and which has made a remarkable record in the elimination of smoke, as well as in the saving of fuel and labor. Besides building the Green traveling link grate, the company does a considerable jobbing business in foundry work. The officers of the company are: P. Albert Poppenhusen, president; Herman A. Poppenhusen, treasurer and general manager, and Joseph Harrington, general superintendent.

The International Electric Meter Company is located at 330 West Randolph street, and owing to its expanding business is preparing to install itself in a much larger factory in the near future. The present line of the company comprises approximately thirty different types of instruments. It has recently added a new design of alternating-current instrument. These instruments are giving very satisfactory results. The officers of the company are: William W. Cheney, Jr., president, and August Benson, secretary.

Among the popular companies acting as manufacturers' agents, as well as making a specialty of repairing motors and generators, is the Arthur Jones Company, located in the Old Colony Building. This company started doing business May 1, 1903, and was incorporated under the laws of the state of Illinois, December 5, 1904. The company carries a large stock of alternating and direct-current motors known as the Arthur Jones motors. The company also makes a specialty of the application of motors to all classes of machine tools, laundry machinery, jewelers' machinery, etc. The officers of the company are: Arthur Jones, president and treasurer; Thomas S. Watson, vice-president and engineer, and Arthur W. Blodgett, secretary.

The Kellogg Switchboard and Supply Company is one of the best-known manufacturers of telephone apparatus in the country. The general offices and factory are located at Congress and Green streets, and branches have been established in New York, Philadelphia, Cleveland and Los Angeles. The company installed its first system a decade ago. To-day Kellogg telephones are in service in every quarter of the globe. The officers of the company are: W. L. DeWolf, president; F. J. Dommerque, secretary; Seymour Guthrie, treasurer; J. B. Edwards, superintendent; J. C. Lewis, sales manager; C. S. Winston, chief engineer, and J. C. Kelsey, sales engineer.

Mathias Klein & Sons make a specialty of linemen's tools, with large factories at 87-89 West Van Buren street and 222-227 Clybourn avenue. The company's office is also at 87 West Van Buren street. The business was established in Chicago in 1857. In addition to handling tools of its own make, the company acts as agent and distributor in this territory for articles made by other manufacturers. The members of the firm are: Mathias Klein, John A. Klein and Joseph A. Klein.

Kohler Brothers, contracting electrical engineers, are among the largest manufacturers of printing-press controllers in the country. The company makes a specialty also of engineering for lighting, power and railways. The members of the firm are: G. A. Edward Kohler and Franklin W. Kohler. Charles R. Kreider is business manager, and Charles A. Dresser, chief engineer.

S. M. McFEDRIES,
Secretary-Treasurer, J. L. Schureman Company.

The J. Lang Electric Company was organized in March, 1902, and took over the old J. Lang & Company's business. The company makes a specialty of panelboards, switchboards, knife switches, etc., and during the year just closed built some of the largest switchboards erected in the West. Warren Ripple is president, and R. S. Ripple secretary and treasurer of the company.

The Metropolitan Electrical Supply Company, located at 184 Lake street, was incorporated September 20, 1897. The year just closed has been the best by fifty per cent of its ten-year existence. The company deals in electrical supplies, both wholesale and retail. There are three outside salesmen and some business is done in foreign countries. The personnel of the company includes William H. McKinlock, president and treasurer; John McKinlock, vice-president; A. J. McGivern, manager, and George B. Liver, manager of store sales.

The Reliance Instrument Company, located at 60-68 West Van Buren street, announces an exceedingly prosperous year in 1907, and, considering the amount of work on hand, as well as orders already booked for the present year, has every reason to believe that the 1908 business will surpass that of last year. The members of the firm are: J. M. Kartholl and R. A. Hall.

Among the manufacturers of automatic motor-controlling devices, the J. L. Schureman Company, located at 70-86 West Jackson Boulevard, enjoys an enviable reputation. This company had its origin in 1903, and was known at that time as Schureman & Lusk. The concern then depended chiefly upon repair work, and was in existence for a short time when Lusk sold out to J. W. Hayden, the firm name being changed to Schureman & Hayden. The company moved into larger quarters and purchased and sold second-hand motors and dynamos and took on a larger amount of repair work. J. L. Schureman, the senior member of the firm, developed a small automatic starter of the solenoid-operated type. This was chiefly designed for automatically starting and stopping motor-driven pumps. From this start a large and complete line of automatic controlling devices has been developed, including elevator controllers, pump and compressor starters, and distant-control switches. In July, 1903, the junior partner, Hayden, sold his interest in the business, and S. M. McFedries, the present secretary and treasurer, entered the firm as sales manager. By this time the controller end of the business had assumed such proportions that it was deemed advisable to close out the stock of motors and dynamos, together with the repair department. The business was incorporated in October, 1901.

The Sunbeam Incandescent Lamp Company is one of the largest manufacturers of incandescent lamps located in Chicago, with offices at 32 West Polk street. The officers are: David J. Kennedy, president; F. S. Terry, vice-president; A. S. Terry, treasurer, and H. B. Vanzwoll, secretary.

The Chicago office of the Westinghouse Electric and Manufacturing Company occupies almost an entire floor in the New York Life Building. The manager is T. P. Gaylord, who has associated with him about forty-five experienced salesmen, almost all of whom are electrical engineers, and who have a thorough knowledge of the company's apparatus. The Chicago office is regarded by the company as one of its most important offices, and it is also known for the harmony and good will which prevail among its men. This can be largely attributed to Mr. Gaylord, whose frank and cheerful disposition has made him a favorite among his men. A feature of the Chicago office worthy of note is that the company has so frequently drawn on this office when in need of men to manage other offices, which speaks most favorably for the training received under the direction of Mr. Gaylord.

Chicago Electrical Show.

THE Electrical Trades Exposition was organized in the fall of 1905 by a number of Chicago men directly interested in electrical development for the purpose of holding annual exhibitions of the product of electrical manufacturers assembled together under one roof for the purpose of advancing the electrical trade in all of its branches. The company includes in its personnel many of the leading electrical men in Chicago and the Middle West.

Beginning as a Chicago enterprise, handled by electrical men for the benefit of the industries represented in Chicago, the first show demonstrated that its scope was national instead of local, and reached to all parts of the country, both in the exhibitors represented and in the attendance of men in the trade.

The third show, which will open on January 13, 1908, and continue for two weeks, promises to greatly surpass all of its predecessors.

Following a new policy, the Exposition Company will provide a uniform booth for all exhibitors, and furnish everything that is required, except the exhibit itself. The design of these booths has been carefully worked out by D. H. Burnham & Company, architects, who have also designed an elaborate scheme of decorations and decorative lighting which will provide a setting for the exhibits, which will greatly add to the effectiveness of the individual exhibits, and the show as a whole.

The officers of the Exposition Company are Samuel Insull, president; Ellsworth B. Overshiner, vice-president; Stewart Spalding, secretary-treasurer. Homer E. Niesz, to whose efforts credit must be given for the two previous expositions, is manager.

It is impossible to give a complete list of things that will be exhibited at the third annual show, but it may be stated that practically every line of electrical manufacture, as well as the allied lines, will be shown. Following is a list of the exhibitors, with such information as to exhibits and attendants found available up to time of going to press:

F. Alexander Manufacturing Company, B 4, 5. The Alexander miniature arc lamp.

American Automatic Telephone Company, K 1. Full line of telephones, including new harmonic bells and a full-sized exhibition set of an automatic system, and a section of automatic switchboard frame with bank and multiples of a 5,000-line board. James S. Brailey, Jr., president; C. D. Juvenal and W. M. Bruce.

American Clock Company, H 4. Electric time systems, time stamps, time recorders and self-winding electric clocks. H. O. Johnson, president; G. F. Randall, secretary; H. W. Pidgeon, superintendent; R. B. Dick and P. J. Hertz, salesmen.

American Conduit Company, F 20. Conduits for underground service.

American Electric Fuse Company, M 2. Small iron frame distributing rack equipped with type H heat coil protectors and auxiliary apparatus; junction boxes, soldering pastes, cable compounds, terminal boxes, soldering irons, black enameled wire, station protectors and can-top terminals. George W. Rodormer.

American Electric Novelty and Manufacturing Company, E 7. Electric portable lamps, dry batteries and electrical specialties.

American Electric Telephone Company, L 15, 16.

American Steel and Wire Company, D 17, 18.

Albert & J. M. Anderson Manufacturing Company, A 2. Switches and line material. H. W. Hincher.

Appleton Electric Company, A 7.

Atlas Anchor Company. Full set of anchors and tools for setting. I. Unger.

M. B. Austin & Company, F 4. Safety Insulated Wire and Cable Company's submarine cables and other materials; Benedict & Burnham Manufacturing Company's "K. K." wire; Thomas & Betts steel outlet boxes, malleable iron bushings and conduit fittings, Gillette-Vibber specialties; General Incandescent Lamp Company's tungsten

HOMER E. NIESZ,
Manager, Electrical Trades Exposition Company.

lamps. A. H. Friend, R. J. Thorne and A. Meinema.

Automatic Electric Company, L 5, 6, 13, 14. Working sections of two intercommunicating common battery automatic exchanges of the 100,000-line system. Twelve telephones are connected to the exhibit and calls are made through the boards precisely the same as in the largest working exchanges.

B. S. Barnard & Company, C 8. Vitrified clay conduit. B. S. Barnard and E. F. Kirkpatrick.

Bates Manufacturing Company, A 3. Numbering machines.

Bristol Company, A 5. Complete line of Bristol recording instruments. H. P. Dennis.

Central Telephone and Electric Company, M 5.

Central Electric Company, D 9, 10. Full line of electrical specialties, including "Okonite" products, D & W Fuse Company's materials, Columbia incandescent lamps, G.-I. specialties and Pittsburg transformers. F. R. Bryant.

Century Telephone Construction Company, K 4, 5.

Chance Manufacturing Company, J 6.

Chicago Fuse Wire and Manufacturing Company, D 4. Exhibit boards displaying "Union" inclosed fuses, inclosed fuse blocks, switch boxes, outlet conduit boxes and covers and fuse wire and fuse links. A. S. Merrill and Clarence T. McDonald.

Chicago Lamp and Reflector Company, B 8, 9. New line of art-glass window illumination. William Block.

Chicago Pneumatic Tool Company, E 5, 6. Complete line of direct and alternating-current drills, grinders, hoists and blowers, with many new and interesting applications of these tools; new and improved portable vacuum-cleaning system for house and office use. J. B. Lamphear, C. B. Coates, Charles Hayes, E. Aplin and James Boswell.

Chicago Telephone Company, D 19, 20. Common battery telephone apparatus and pay-station equipment.

Chicago Telephone Supply Company, M 4.

Colonial Art Glass Company, G 3, 4.

Commonwealth Edison Company, I 2, 3, 4, 5, 6, 7, 8. An elaborate installation showing every room of a residence completely equipped with all details of electrical application.

Frank B. Cook, M 6, 7, 8. Telephone protective apparatus. Frank B. Cook and C. N. Newburn.

S. H. Couch Company, J 6. Telephone supplies. S. H. Couch.

Crane Company, C 4. Steam and oil separators, valves and fittings. J. A. Minwegen.

Crescent Company, A 10.

John F. Cullerton, K 1.

Dean Electric Company, L 11, 12. Telephones, switchboards and telephone auxiliaries.

Joseph Dixon Crucible Company, A 4. Motor brushes, graphite lubricants. F. R. Brandon, B. B. Worley.

Dossert & Company, C 21. Solderless connectors.

Duplex Metals Company, C 5. Exhibiting "Monnot" Duplex metals for electrical conductors.

Arthur O. Einstein, E 12. Outlet boxes, knife switches, flexible conduit connectors and couplings, rubber gum and friction tapes. Arthur O. Einstein.

Electric Appliance Company, E 8, 16. Sangamo wattmeters, Packard tungsten lamps, Packard transformers, "Paranite" wires and cables, Couch & Seely telephone apparatus, "Faraday" and weatherproof bells. P. R. Bool, R. S. Mitten and F. J. Alderson.

ELECTRICAL REVIEW, F 22. Represented by P. S. Dodd, L. W. Marshall and A. A. Gray.

Electric Storage Battery Company, F 5. "G 51" Chloride Accumulator elements having a capacity of 4,000 ampere-hours; batteries for small lighting and telephone plants; batteries for railway service and for car-lighting service; "Exide" batteries for vehicle work and sparking. Godfrey H. Atkin and J. M. S. Waring, and Messrs. Bauer, Marshall and Rath.

Erwin & Company, D 3. House pumps and applications of the motor drive.

Federal Electric Company, J 3, 4.

Fort Wayne Electric Works, C 13. Type K wattmeters for single-phase and multiphase circuits and prepayment wattmeters, together with a new calibrator for alternating-current transformers; arc lamps, both alternating and direct current, and for series, multiple or power circuits; a complete line of various fan motors—desk type, universal bracket, revolving, "Dragon" bracket and telephone booth fan motors. W. S. Goll.

General Compressed Air and Vacuum Company, F 17, 18, 19. Portable wagon with class C outfit used in house-to-house cleaning; two-wheel portable compressed-air and vacuum outfit for steam and electric railway-car cleaning; portable truck for mills, factories, laboratories, etc.; portable hand-bucket device for hotels, office buildings, etc. Thomas F. Clohesey, A. S. Foote, John M. Roger, W. H. Averill, John A. Dunlap and D. Patrick.

General Electric Company, F 1, 2, 3, 10 and 11. Motors and generators, electrical measuring instruments, house-service apparatus, lighting and cooking utensils, in-

candescent lamps, arc lamps, transformers, cleaning and vacuum apparatus.

Illinois Electric Renovator Sales Company, E 4.

International Correspondence Schools, H 7. Historical exhibit and display of text-books and students' work. B. H. Warren and C. E. Freelove, F. H. Tigue, W. M. George, Thomas Conroy, J. B. Kevan, C. C. Marson, B. H. Nymeyer and H. S. Hoover.

International Telephone Manufacturing Company, M 11. Telephone apparatus, "Transmittophone," "Telephograph" and a new "Auricuro" or loud-speaking telephone.

Jewell Electrical Instrument Company, G 8.

H. W. Johns-Manville Company, E 15. "Victor" combination meters, the "Linolite" system of lighting, asbestos wood, "Noarc" fuses and fuse devices, "J-M" friction tape, molded mica; "Monarch," "Phœnix," "Vulcabeston" and "Electrobestos" insulations, asbestos pipe coverings, roofings, packings and house specialties. H. M. Frantz, F. C. Frumveller, A. M. Chamberlin, A. M. Erskine, M. H. Crosswell, G. A. Saylor and W. F. Little.

Monarch Electric and Wire Company, C 23, 24. Weatherproof wires and cables, galvanized strand, rubber-covered wires and cables, lamp cord, packing-house cord, stage cable, flaming arc lamps, incandescent lamps, portables.

Monarch Telephone Manufacturing Company, L 1, 2. Switchboards and telephones. E. E. Yaxley, J. C. Hubacher, W. H. Trimm, R. C. Stone, A. J. Carter, T. L. Dunlap and M. E. Hall.

Moon Vibrator Company, D 1. Electric vibratory apparatus.

McDowell-Stocker Company, E 18.

McRoy Clay Works, F 21. Clay conduits.

National Electric Lamp Association, E 21, 22, 23. Incandescent electric lamps and reflectors. S. E. Doane, George Loring and W. N. Skiff.

North Electric Company, K 6, 7. Telephone apparatus and the Clement "Automanual."

North Shore Electric Company, E 2, 10. Electrical appliances and devices for demonstrating the use of electric current.

Nungesser Electric Battery Company, B 7.

Roth Brothers & Company, F 7. Electric blowers and exhausters, polishing and grinding lathes and type S and type T motors and generators. G. A. and C. H. Roth, W. J. Warder, Jr.; E. O. Benjamin, J. F. Kadic, William Roth and F. O. Creager.

Shelton Electric Company, C 14. Vibrators.

Simplex Electric Heating Company, C 19, 20. Electrical heating apparatus.

Solar Electric Company, B 6. Advertising incandescent lamps.

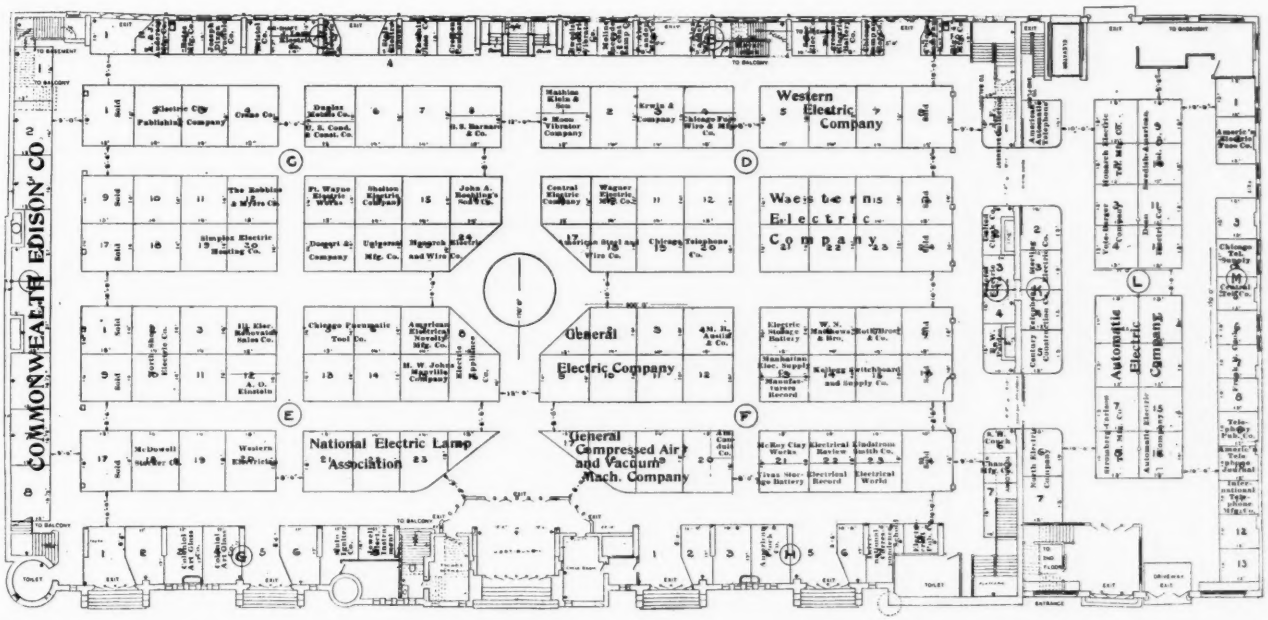
Sterling Electric Company, K 2, 3. Telephone apparatus.

Stolz Electrophone Company, A 8. Electrical acoustic devices.

Stromberg-Carlson Telephone Manufacturing Company, L 7, 8. Full line of telephone apparatus, including switchboards and telephones and cord products, magnet wire, aerial and underground cable.

Swedish-American Telephone Company, L 9, 10. Telephone instruments and switchboards.

Swedish Electric Vibrator Company, B 2. Electrical vibratory devices.



ARRANGEMENT OF EXHIBITS, THIRD ANNUAL ELECTRICAL SHOW, COLISEUM, CHICAGO, ILL., JANUARY 13-25.

Kellogg Switchboard and Supply Company, F 14, 15. Apparatus relating to all branches of telephony and an oscillograph for showing the various wave-forms of pole-changers, magneto generators, voice currents, etc.

Mathias Klein & Sons, D 1. Linemen's tools.

J. Lang Electric Company, A 6. Switches, panel-boards and switchboards. R. S. Ripple, O. B. Duncan and E. Hawkinson.

Lindstrom-Smith Company, F 23. "Red Cross" electric vibrators.

Manhattan Electrical Supply Company, F 13. Various electrical specialties. A. R. Johnson, Clarke H. Methot, George Holly, A. Holland, T. L. Parker and W. Haeger.

W. N. Matthews & Brother, F 6. "Stombaugh" guy anchors, "Hargis" cable-splicing joints, "Kearney" cable clamps, "Lima" jack plugs, "Callahan" cable rollers, "Holdfast" lamp guards, "O. K." sleet cutters, "Easy" cord adjusters, lamp adjusters and "Easy" bright reflectors. C. L. Matthews, Victor L. Crawford and Orville R. Johann.

Moline Incandescent Lamp Company, B 3. A reproduction six and one-half inches high and thirty inches in diameter of the "1900" telephone battery. Thomas G. Grier, H. S. Greene and H. G. Robbins.

F. W. Pardee, J 5. "Rock Island" dry cells; Wire and Telephone Company of America bare copper and magnet wire, rubber-covered telephone wire, fixture wire, annunciator wire and office wire; Electrose Manufacturing Company receiver shells, mouth pieces, switch handles and molded pieces; Peru Electric Manufacturing Company electric porcelains and Lippincott Glass Company inner arc globes. Frank W. Pardee.

Phoenix Glass Company, A 9. Incandescent electric light globes and shades in rich cut, etched, white acid and roughed inside designs; decorative domes and shades for portables; "Phoenix Quality" inner globes for inclosed arc lighting systems. E. H. Fox and C. C. Fricke.

Robbins & Myers Company, C 12. Fan motors.

John A. Roebling's Sons Company, C 16. Wires and cables and rail bonds.

United Clock Company, J 2. Electrical clocks and time stamps.

United States Conduit and Construction Company, C 5.

Universal Manufacturing Company, C 22.

Vivax Storage Battery Company, F 21. Ignition, vehicle, lighting and launch batteries.

Vote-Berger Company, L 3, 4. Complete multiple section of ballast common battery switchboard, ringing machine, power board, charging machines and storage batteries, pendant telephone and direct-current common battery telephone, adjusters for incandescent lamps and "D. & T." guy anchors. A. J. Schoephoester, P. W. Goodman, C. D. Enochs, J. N. Wallace and M. I. Berger.

Wagner Electric Manufacturing Company, D 10. Complete line of electrical measuring instruments, single-phase and polyphase motors and transformers.

Western Electric Company, D 5, 6, 7, 13, 14, 15, 21, 22, 23. Alternating and direct-current arc lamps, insulation specialties, fan motors and line material.

REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE

A Method of Controlling the Spark Discharge of Condenser Circuits.

When working with circuits containing condensers and inductances which discharge across a spark-gap, difficulty is met in controlling this discharge so as to maintain it regular. This fact has made experimenting with spark-gaps difficult and uncertain. A method of overcoming this difficulty and of giving entire control over the gap is described here by W. Eickhoff. The method is simple, consisting merely in placing a pointed curved wire on one of the supports for the discharging electrodes. This wire is carried forward around the electrode until it is in line with the point nearest to the opposite electrode. The wire is preferably attached to that electrode which is negatively charged. In this position the action of the spark-gap becomes regular and is under entire control; otherwise, it is not affected, the pointed wire not appearing to take any part in the discharge. It is suggested that this method of controlling spark-gaps is suitable not only for scientific research, but for use in wireless telegraphy, and also for lightning arresters of the horn type, as it enables the gap to be set so that it will discharge with certainty at a definite potential. — *Translated and abstracted from the Physikalische Zeitschrift (Leipsic), December* 15.

Electrically Operated Sluice-Gates for the Shoshone and Pathfinder Dams.

The high-pressure gates for the Shoshone and Pathfinder dams are remarkable for the high heads under which they are to be operated and for the quantity of water they will be called upon to control and discharge. For these reasons special care has been given to the design of the gates and their operating mechanisms, which was carried out by A. H. Ensign, of the United States Reclamation Service. They are here described in detail by F. W. Hanna. The Pathfinder dam, at which the first group of gates is being installed, is situated in Wyoming, on the North Platte river. It is a part of the development of the North Platte irrigation project. The dam is 210 feet high, 226 feet long at the top, and forms a reservoir which will hold something over 1,000,000 acre-feet of water. The Shoshone dam is in a precipitous canyon eight miles above Cody, Wyo. It is a part of the Shoshone project. The dam is almost a duplicate of that of the Pathfinder, except in height, length and bottom width. The total height is 310 feet. The dam will form a reservoir holding 500,000 acre-feet of water. The sluice-gates in each case are to be installed in an outlet tunnel passing around the end of the dam through a solid granite cliff. The Pathfinder outlet tunnel is 480 feet long with a rectangular cross-section thirteen feet wide and nine feet to the spring lines of the arch roof. The maximum height is ten feet. It is located so that its bottom at the gate seats is 194 feet below the top of the dam. The Shoshone outlet tunnel is the same length, but has a smaller cross-section. The gate seats are about 233 feet below the top of the dam. The Pathfinder gate chamber is located near the end of the axis of the dam, at about mid-length of the tunnel. It is separated into four passageways by means of three concrete piers. The Shoshone chamber is practically identical with the other, except that there are but three gates. The body of each gate is seven and one-half feet long and four and one-half feet wide, closing a waterway seven feet by three feet eight inches in section. The gates are ribbed and the contact portion is covered with bronze strips to facilitate sliding on corresponding bronze surfaces attached to the gate frame. The specifications for these bronzes required that they should stand a pressure of 3,000 pounds per square inch and a velocity of thirty feet a second without chattering. The total weight of each gate is about 10,000 pounds and the maximum friction-producing pressure to which the Shoshone gates will be subjected will be 440,000 pounds. Assuming the starting friction of bronze to be 0.25, the total friction in gravity load for each gate is approximately 120,000 pounds. The operating mechanism consists of an oil cylinder for each gate. The oil is supplied from a tank at the power-house and is kept under pressure by means of a pump driven by a motor, the power for which is drawn from a gasolene engine and dynamo. The gates are controlled by operating valves placed at the switchboard, by means of which oil can be admitted to either end of any cylinder, thus opening or closing any gate. The pressure is automatically maintained by the motor, and relief valves are supplied for preventing excess pressure or an inrush of air into the oil tank. The air-valve is maintained closed by a pressure slightly greater than the atmospheric. This is to prevent frequent changes of air which would bring in moisture. The relief valve, preventing excess pressure in the oil tank when opened for this cause, overflows into a bucket, which, when filled, throws a switch and stops the motor. This bucket has an opening in the bottom which allows the oil to flow out again, thus restarting the motor. This opening also prevents shutting down the motor for a temporary rise of pressure. The engine is rated at fifteen horse-power, and drives a fifteen-kilowatt generator. The motor is rated at seven and one-half horse-power, and is directly geared to the pump, and is equipped with a speed-controlling rheostat. The pump is of the triplex type, and delivers fifteen gallons of oil a minute under a pressure of 600 pounds to the square inch.—*Abstracted from the Engineering News (New York), February* 2.

The Management of Production in a Great Factory.

The system adopted for dividing the responsibility and authority in one of the great electrical manufacturing establishments is described here by G. F. Stratton. This is the large General Electric establishment at Lynn, Mass., where more than ten thousand hands are employed. The system which has been developed here for controlling the factory may be described concisely as follows: The manager is responsible for the entire working and gets all the credit or blame. The engineering department designs the work and tells the factory what to make. The superintendent of production tells the factory how much or how many to make. The mechanical superintendent decides how the work is to be done and sees to the carrying out. The administration centres in the president. Directly under him are the first and second vice-presidents. The first is responsible for the sales and engineering departments, including the drafting department. The province of the engineering department is the purely scientific end of

the business; it has nothing to do with the manufacturing except to watch closely to see that instructions and drawings are rigidly followed and the materials used are those specified. Its concern is entirely with the reputation of the goods. The second vice-president is at the head of the production department, a general charge involving the plant, its equipment, and the entire line of manufacture. Briefly, he makes the goods; the first vice-president sells them. The second vice-president is also in control of the experimental department, which covers mechanical tests, investigations, and the securing of inventions and patents. The executive head of the factory proper is the general manager. His responsibility commences with the receipt of orders from the commercial department and ends when those orders are shipped out. He is responsible for the buildings and equipment, for their design and arrangement, the purchase of supplies, the handling of the working force, the wages paid, and every item of shop expense. He is responsible, in a great measure, for manufacturing at prices which will insure successful competition with other shops. Immediately under him are the mechanical superintendent, the purchasing agent, the superintendent of production and the factory accountant. The mechanical superintendent has charge of the shops and machinery and the discipline of the men. He has four assistants: a superintendent of construction of buildings, a tool expert, the shop foreman, who looks out for the discipline of the shop, and an engineer of light, power and heat. He has nothing to do with the fixing of wages; they are determined by the various foremen in consultation with the general manager. The purchasing agent secures everything required in the factory or office, and he has a corps of assistants and a system of records making comparison of past prices easy. The superintendent of production receives orders for manufacturing or shipping from the commercial department and distributes shop orders to the various foremen and to the head shipper. An important duty of his department is that of keeping track of the stock of finished products ready for shipment and of such products in course of construction, so as to enable the manager to determine readily the condition of affairs throughout the factories. It is to this department that the shop foremen come for orders to keep their men going, and upon its intelligent distribution of orders depends largely the steady and frictionless flow of work in the shop. The shop accounting department under the general manager is in three sections: one keeps account of the purchase of supplies, shop expenses, costs of construction, etc.; another keeps an elaborate systematized record of the cost of manufacturing; the third section is the paymaster's, where day and piece-work are figured and the pay-rolls made up. In addition to these regularly constituted authorities, there are committees for various purposes. There are two standing committees. One is a manufacturing committee before which questions of the desirability of new lines of manufacturing or discontinuing old ones are decided. It is formed by representatives from the sales department and the engineering department, by the mechanical superintendent and superintendent of production. The other committee is known as the "shop-plant committee." It decides upon questions or radical changes in the arrangement of existing shops, and the location and equipment of new ones. Its members are the general manager, the mechanical superintendent, and the principal shop foremen. These committees hold regular meetings, and special meetings are frequently called by the general manager to discuss questions of shop policy.—*Abstracted from the Engineering Magazine (New York), January.*

Electrically Equipped Railway Shops in the Argentine.

A description is given here of the new workshops of the Buenos Ayres Western Railway in Argentine. These are entirely driven by electric motors. The shops are about eleven miles from Buenos Ayres and comprise car and car-building and repair shops, locomotive-erecting shop, boiler, smith, and general machine and wheel-turning shops, iron and brass foundries, copper, tinsmiths', painting and varnishing departments, sawmill, etc. The machinery throughout is driven by three-phase motors at 440 volts, power being drawn from a central power station which supplies electrical energy and compressed air for the pneumatic tools. The car-building and repair department has ten tracks passing through it. It is served by a motor-driven transfer table. A number of small tools here are operated by a five-horse-power motor. The sawmill, carpenters' shop, coach-building, repair department, upholsterers', etc., departments are grouped together in one building, which is served by an electrically driven transfer table running across the whole width of the yard. This table is seventy feet long and capable of carrying forty-five tons. It is driven by a ten-horse-power Westinghouse induction motor. The entire equipment throughout has been furnished by the British Westinghouse Electric and Manufacturing Company, Limited. A system of individual motor drives is largely adopted in the sawmill on account of the intermittent work. There are here twenty-three motors, aggregating 307 horse-power, the largest being rated at sixty and the smallest at three horse-power. In the locomotive section, as well as in all the metal-working departments, the machine tools are arranged along the walls and driven from motor-operated line shafts. Here there are a number of electrically operated cranes traversing the full length of the shops and serving all the machines. The total power consumed in the wheel shop is fifty-six-horse-power; this includes two cranes. The blacksmith shop contains four Westinghouse motors for driving the air-compressors; these aggregate eighty-five-horse-power, the largest being rated at forty and the smallest at ten horse-power. The general machine shop has its tools belted to nine short-line shafts, each of which is driven by an induction motor carried on cast-iron brackets, secured to the walls eight feet above the floor level. These motors all run at the same speed, 925 revolutions per minute, and drive the shafts through two reductions of belting. The equipment consists of two five-horse-power and seven ten-horse-power motors. This shop is also served by an electric range. The iron and brass foundry has a number of emery wheels, rattlers and other devices driven by a small motor. There is here a five-ton electrically operated crane. The blast is furnished by two blowers, each geared to a fifteen-horse-power motor. Other machinery here is driven by electric motors aggregating thirty-eight horse-power. The locomotive-erecting shop is served by four thirty-five-ton electric cranes. The motors are all of the three-phase type, being operated at various voltages from transformers having a number of taps. In the boiler house there is an electrically operated twenty-five-ton crane operated by two ten-horse-power motors. The power plant consists of two bituminous-coal gas producers, each capable of gasifying ten tons of coal in twenty-four hours. The engine room contains four Westinghouse three-cylinder gas engines, direct connected to three-phase alternators. Three of these engines are rated at 250 horse-power, coupled to 150-kilowatt generators; the fourth is rated at 125 horse-power and is coupled to a seventy-five-kilowatt generator. The power is delivered at 440 volts, fifty cycles, the generators operating in parallel.—*Abstracted from the Electrical Review (London), December 20.*

INDUSTRIAL SECTION

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS

A New Separable Wireless Cluster.

The Benjamin Electric Manufacturing Company, Chicago, Ill., has designed a separable wireless cluster which is a long step in advance of any cluster which has

FIG. 1.—TYPE 5 SEPARABLE WIRELESS CLUSTER.

heretofore been placed on the market. This cluster consists practically of two units, the upper metallic supporting cap or base containing the porcelain insulating base, with its contacts and binding-posts, and the lower, or body portion, containing the required number of socket shells, with the necessary multiple connections.

The type 5 cluster is made with the bottom portion of the body finished ornamentally, and the type 5K cluster is arranged for a lamp coming down through the cen-

FIG. 2.—TYPE 5-K SEPARABLE WIRELESS CLUSTER.

tre. With the type 5K cluster a third binding-post is arranged, so that the bottom lamp may be operated independently of the other lamps in the cluster. If this is not desired, it is only necessary to carry the wire across two of the binding-posts.

The principal feature of this separable wireless cluster lies in the compact way in which the entire assembly of the unit is constructed. The upper and lower portions lock together, and intimate contact is made between the current-carrying members by simply inserting the upper portion into the lower and giving it a partial revolution, firmly locking the two pieces together. With this type of cluster it is possible for the supply man or contractor to eliminate from his stock a large part of the supply material which nowadays encumbers his shelves. He can keep in stock one specific line of clusters, assorted as to the number of lights. If an order comes in for a quantity of clusters taking a specific number of lights, not in stock, he can turn in his order for the required number of clusters, but, in the meantime, the upper portion of the clus-

FIG. 3.—TYPE 5-K SEPARABLE WIRELESS CLUSTER FITTED WITH ORNAMENTAL DETACHABLE HUSK.

ters in stock can be furnished and installed, and when the new shipment arrives, all that is necessary is to take the body portions from the new shipment, clamp them in place on the already adjusted upper fixtures, and retain in stock the original bodies and the new upper portions.

This separable wireless cluster also facilitates installing, renewing or cleaning of glassware. It is not necessary for a workman to stand on a high ladder and take each lamp individually out of its socket and clean it, or take down all the lamps, one by one, in order to clean a shade or reflector. By taking the body portion firmly in the hand, after removing the centre lamp and slacking off the other lamps, it may be separated from the upper part, and the lamps and auxiliary devices, such as shades and reflectors, brought to a low table and cleaned or readjusted.

The body is made of such dimensions that a standard shade with a three-and-one-quarter-inch fitter, can be easily passed over it without making it necessary to disturb the wiring connection.

The accompanying illustrations indicate very clearly the advantages of this cluster. Fig. 1 shows the type 5 cluster, and Fig. 2 the type 5K. The copper cap is shown separated from the porcelain body portion, but after the cap is once fastened to the fixture the two pieces become an absolute unit. Fig. 3 shows the type 5K separable wireless cluster equipped with a new stamped brass husk which the Benjamin Electric Manufacturing Company has recently developed for ornamenting clusters or single lamp sockets.

These separable wireless clusters, in addition to their great facility of adjustment, present a very handsome appearance. They are made exclusively for multiple connection and for indoor work. Being fitted with short metal socket shells, the body occupies very much less space, although the contacts are widely separated, and the fibre insulation guarantees absolute protection. The metal shell also makes possible the use of standard shades on the individual lamps, and the body may be finished to match any finish or trim required.

Wagner Transformers.

The Wagner Electric Manufacturing Company, St. Louis, Mo., has been a specialist in the line of transformer manufacture since 1892. In the field of power-transmission apparatus the company invites specifications for 60,000 volts or less in unit capacities of any size. In this field the company has been well to the front. In 1896 it built the first oil-filled, water-cooled transformers for the 10,000-volt system of the Redlands-Riverside (Cal.) Transmission Company. These transformers are still in successful operation. In 1898 it built for the Telluride (Col.) Power Transmission Company the first 40,000-volt transmission transformers installed in America. These units are still in successful operation. In 1898 it built for the Union Carbide Company, for service at Niagara Falls, N. Y., the first 1,500-kilowatt transformers, at that time fifty per cent larger than any previous

units built. These seven units are still in successful operation.

Coming down to recent times its most important contract calls for the transmission apparatus required in the $5,000,000 irrigation project of the national government in the Salt river district, Ariz. This contract calls for thirty-six units, including eighteen 350-kilowatt, 26,000-volt transformers and eighteen 235-kilowatt, 23,000-volt transformers, all being twenty-five-cycle, oil-filled, water-cooled, the specifications for which were very rigid as regards efficiency, regulation and breakdown tests.

An Effective Show-Window Illumination.

A great deal of rivalry exists between the large department stores, many of which employ men commanding large salaries for their ingenuity, taste and ability in displaying the various goods to the best advantage. It is well recognized that the most valuable ally these stores have is the electric light. It is used in many ways, and great skill is displayed in its application to show-window dressing. Probably nowhere in the world is this competition so keen as in State street, Chicago, Ill.

The State street windows of The Fair store occasioned not a little comment, due to the fact that the management had installed in some of the windows a reflector resembling a searchlight. This new reflector, because of its shape, is called "Helmet," and in connection with the new high-efficiency Gem lamp is intended for high windows such as those of The Fair store.

This "Helmet" reflector, like the "Poke-Bonnet" and other styles of X-Ray reflectors, is made of the finest quality of crystal glass and is plated with sterling silver, backed with a specially prepared enamel which will stand the heat of an incandescent lamp without blistering, peeling or in any way deteriorating. It also prevents the silver from tarnishing and absolutely retains the brilliancy of the silver indefinitely.

The Fair windows are about eighteen feet high. The "Helmet" shows no noticeable depreciation in illumination up to a distance of twenty feet from the source of light. Its construction is similar to that of the searchlight; it reflects as does the searchlight parallel rays of light. The "Helmet" system of illumination is considered ideal by eminent illuminating engineers, for windows of this class; that is to say, windows ranging from twelve to twenty feet in height.

The "Helmets" in The Fair store are attached to conduit pipe and are placed two and one-half feet apart, but ordinarily are merely suspended from a socket by means of a three-and-one-quarter-inch shade-holder. The flat side of these reflectors is placed next to and parallel with the plate-glass.

The "Helmet" is twelve inches in diameter and is eleven and one-half inches high. The angle of distribution is shown in the chart on page 84. This reflector takes the Gem high-efficiency lamp either in 125 or 187-watt units. The "Helmet" is very carefully worked out on scientific lines, which fact combined with the sterling-silver plating accounts for the very noticeable difference in window illumination in The Fair windows, as shown in accompanying photographs. Many who have

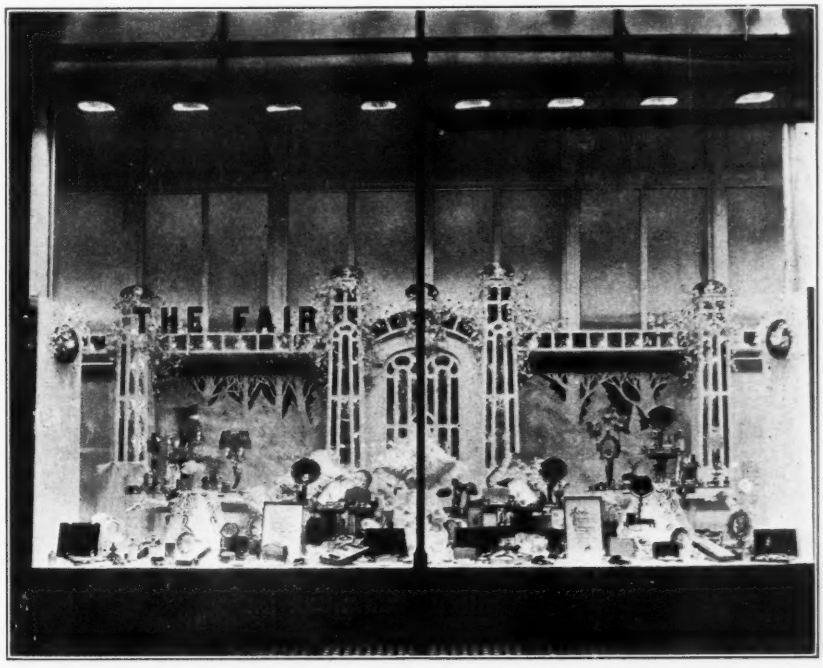
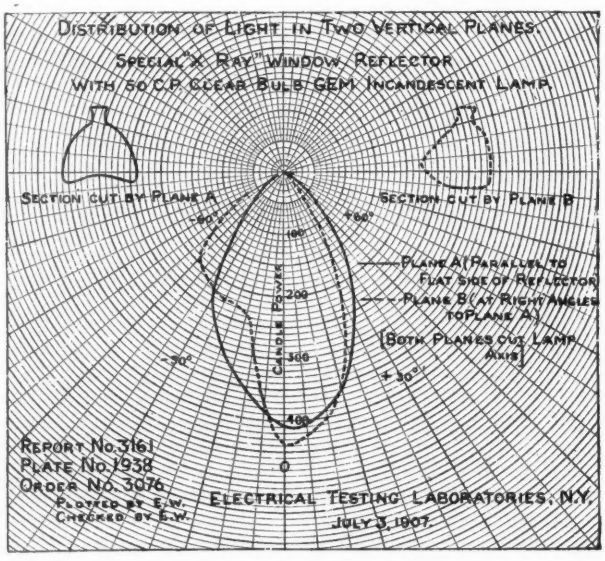


FIG. 1.—WINDOW EQUIPPED WITH "HELMET" REFLECTOR.

FIG. 2.—WINDOW EQUIPPED WITH CONICAL MIRROR REFLECTOR.

compared the two systems of illumination in these windows have asserted that there is an apparent difference of fifty per cent in favor of the "Helmet" installation. A fairly good idea of the difference in illumination may be formed by comparing these photographs, which were taken under fair competitive conditions. The consumption of current is the same or practically so in both tests. Fig. 1 shows eight "Helmets" fitted with eight 125-watt Gem high-efficiency lamps. Fig. 2 shows eighteen twelve-inch sectional mirror cones fitted with eighteen fifty-five-watt lamps. The "Helmets" are installed closer together than is really necessary, and ordinarily they should be installed in high windows at a distance of three feet apart from centre to centre. When installed in this way they will give the maximum amount of light at minimum cost.



CURVES SHOWING LIGHT DISTRIBUTION FROM "HELMET" REFLECTORS.

One Chicago company, W. A. Wieboldt & Company, has made a very careful test of the "Helmet" system of lighting, and has reported that it installed three "Helmets" in one show-window, using 187-watt Gem high-efficiency lamps, and that these three "Helmets" replaced thirty-six sixteen-candle-power reflector lamps. It was estimated that if these reflectors were installed in all the windows of this company it would result in the remarkable saving of $1.05 per hour in show-window lighting bills, besides furnishing ideal window illumination.

It is thought by some of the best-known illuminating engineers that the "Helmet" reflector will prove to be as much in demand for high and shallow show-windows, that is to say, windows from twelve to twenty feet high by six to eight feet deep, as has the "Poke-Bonnet" window reflector for low or average and deep windows. It will be remembered that the "Poke-Bonnet" window reflector is also made by the National X-Ray Reflector Company. Over forty thousand of these have been sold and installed since being placed on the market some twenty months ago.

This reflector is fourteen inches long, is fitted with a twin socket, taking two sixteen-candle-power lamps, or two forty-watt tantalum lamps. This reflector is also fitted with a cleverly devised adjustable device. By means of this the rays of light can be directed to any desired angle.

The reflectors are wired complete for installation, including swivel attachment plug. The trade can readily carry these in stock, enabling it to install this new form of trough reflector the same day as receiving order.

These reflectors are installed in units of three feet apart. Rays of light meet at this distance, giving the user great illumination and directed in the most useful places in the window area and resulting in a saving of one-third in lamps.

Again referring to the "Helmet" reflector. It might be of interest to many to know that while the "Helmet" was intended primarily for window lighting, it is meeting with much favor and success for illumination in audience rooms, factories and foundries. It is, in fact, ideal wherever powerful concentration of light rays is required at a distance ranging from twelve to twenty or even forty feet.

B. S. Barnard & Company Establishes Western Office.

B. S. Barnard & Company, 39-41 Cortlandt street, New York city, manufacturer of electrical clay conduits for underground work, with factories throughout the West, has established an office in Chicago in the Monadnock Building.

B. S. Barnard, who is still identified with the trade as president of the Standard Vitrified Conduit Company, with factories in New Jersey, is also president of B. S. Barnard & Company, and will retain his headquarters at the New York office, managing the sales both of the Standard Vitrified Conduit Company and B. S. Barnard & Company. Mr. Barnard has been identified in the electrical field for the past fifteen years. He is thoroughly conversant with the requirements of the trade in this line, having successfully executed many of the largest conduit propositions given out during his career, and is very highly regarded in the electrical field.

He is a member of the National Electric Light Association and National Independent Telephone Association, the Railway Club, and several of the leading clubs in New York city.

The western office will be in charge of E. F. Kirkpatrick, who occupies a position throughout the West equal to that of Mr. Barnard in the East. It is a combination that will be appreciated and highly regarded by the trade. Mr. Kirkpatrick is familiarly known as "Kirk," and has been for years with the General Electric Company, Westinghouse Company, Fort Wayne Electric Company, and lately very active in the manufacture of clay conduits. Mr. Kirkpatrick enters the corporation of B. S. Barnard & Company as vice-president, managing the Chicago office. His success from the start is assured, as the electric light and telephone companies throughout the West could hardly consider the construction of a conduit system unless "Kirk" had something to say as to how the conduit should be laid and the kind to be used.

B. S. Barnard & Company's western factories will place their western office in a position to quote very favorable prices, on account of the advantage in freight rates, and more especially the very high quality of their conduit, which is made of superior clay, and produced by the very best element of labor in the art of clay product.

The Electrical Show in Chicago, likewise the National Telephone Convention, will find on exhibition the product of B. S. Barnard & Company, which will be in charge of Mr. Barnard and Mr. Kirkpatrick jointly.

"Okonite."

In almost every electrical trade journal one may peruse, whether casually or methodically, one's attention is arrested by a semicircular or half cross-section of an insulated wire, outlined in the insulation of which appears the word "Okonite." Few in the telephone or in the electrical trade generally fail to understand the significance of this word; though its derivation is not infrequently a puzzling topic of discussion.

It may please our readers, therefore, to learn that "Okonite" is a coined word indicating a high-grade rubber compound used for insulating electrical conductors.

This compound, then unnamed, was first experimentally used to insulate wire in the year 1883. The excellent results attending its use by the then only important electrical interests in the United States (telephone, telegraph and electric light), indicated the wisdom of forming a company to manufacture insulated wires and cables with this rubber compound as a base.

What to name the material and the company became a matter of consideration the following year (1884); and accordingly two of the more actively engaged gentlemen in this enterprise took the subject in hand. Having the telegraph business in mind they first took the telegrapher's signal for understanding, "O K" (in telegraphy . . . — . —), their idea being to have those the first two letters in the new word.

At that time an insulating material called vulcanite was greatly interesting the electrical world; and to lend a familiar sound to the new word the letters N I T E were fixed to the letters O K, producing the word Oknite.

This, though suggestive, lacked harmonius expression, to secure which an O was inserted between the K and N, and the new compound, with the new word "Okonite," was launched on the uncertain sea of electrical endeavor. The company was called the Okonite Company. At the same time a half cross-section of wire was drawn—the insulation being represented in black (the color of Okonite) —on which were printed in white letters the word Okonite.

This was at once adopted as the trademark of the company, which immediately thereafter began the manufacture of insulated wires and cables as a corporation.

The word Okonite soon became a familiar sight in all the trade journals—a word indicating an excellence of workmanship and material entirely justifying the slogan of The Okonite Company: "The Standard for Rubber Insulation."

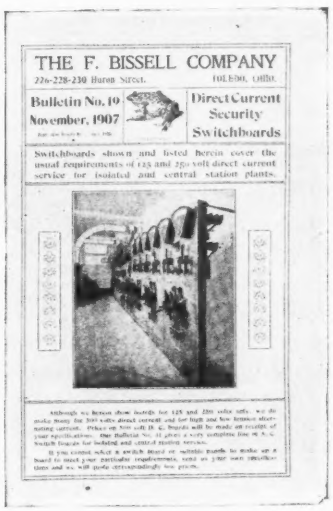
And as if to further justify this contention, the creators of the various encyclopedias and dictionaries deemed "Okonite" sufficiently standard in its field to find a place for it in their publications.

The word properly defined, however, all others to the contrary notwithstanding, is: A vulcanized-rubber compound consisting of fine Para rubber only and other materials; used for covering and insulating electrical conductors.

Thus was a new noun born to the English language.

The F. Bissell Company.

The F. Bissell Company, Toledo, Ohio, has recently issued a very complete switchboard catalogue devoted to direct-current "Security" switchboards. In this bulletin each different type of direct-current


THE F. BISSELL COMPANY

226-228-230 Huron Street. TOLEDO, OHIO.

Bulletin No. 19 November, 1907

Direct Current Security Switchboards

Switchboards shown and listed herein cover the usual requirements of 125 and 250-volt direct current service for isolated and central station plants.

switchboard is carefully illustrated, and the description is so comprehensive that a customer can arrive at the price of any switchboard without further correspondence. This bulletin should be found of great value to consulting engineers and designers having occasion to work out switchboard problems.

United States Trade with Germany.

For the five months ended with November, 1907, the following domestic exports were made to Germany from the United States:

Copper ore, matte and regulus, thirty-five tons, valued at $9,000. For the same period in 1906 this was fifty-nine tons, with a value of $12,909. Copper ingots, bars, plates, etc., 51,401,272 pounds, with a value of $8,744,360; for the same period in 1906, 41,790,733 pounds, with a value of $8,052,370. Electrical appliances, $138,123. For the same period in 1906 this was $152,040.

A Unique Advertisement.

The F. D. Lawrence Electric Company, Cincinnati, Ohio, is sending to its friends a unique advertisement in the form of a menu arranged as follows:

MENU

Rotary Converters

Butts — Ohms — Volts

Blue Stone

Electric Eels

Storage Battery

Kilowatts

Transformers au Juice

Blowouts — Mushroom Anchors

Armatures

Frozen Currents

Automatic Cutoffs — Pièce de Résistance

Acidified Berries

Fuses

ANY ONE ORDERING FROM THIS BILL WILL BE SHOCKED

The front page of this menu is embellished with a very handsome portrait of the head of the company, Frank D. Lawrence.

The Phoenix Glass Company.

The Phoenix Glass Company's productions in glassware for all lighting systems are justly regarded as of the highest excellence—as to design, workmanship and quality—being the careful work of the most experienced glassworkers of the present time.

The company's inner globes have a well-deserved reputation—every detail and requirement receiving attention—and their quality is proclaimed by their having been adopted by many of the largest central stations and supply dealers in the country. In addition, their fame has reached foreign countries, from which many large orders are being received.

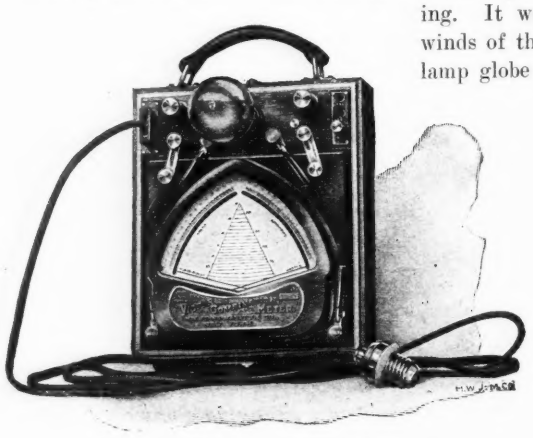
The novelty in design and quality of their incandescent electric glassware is well known, special attention being given to effects in perfect harmony with the prevailing designs of lighting fixtures. A few of the many buildings in which "Phoenix Quality" glassware is to be found are:

Hotel Belmont, New York; Waldorf-Astoria Hotel, New York; Bellevue-Stratford Hotel, Philadelphia; Hotel Fairmont, San Francisco, Cal.; St. Charles Hotel, New Orleans, La.; St. Regis Hotel, New York; the buildings of the New York Life Insurance Company in many of the principal cities of the country; various state capitol buildings; all of which is evidence of the fine quality of all the productions of the Phoenix Glass Company, New York.

Victor Lamp-Testing Meter.

A new type of direct-current meter has been placed on the market by the H. W. Johns-Manville Company, 100 William street, New York city, which offers many advantages to the inspector, lamp salesman, lamp manufacturer, etc.

The movements are built on the familiar D'Arsonval pattern, and so placed with reference to each other and the scale as to render the energy consumption directly readable at the intersection of the volt and ampere indicator needles, the special feature being the design, which enables the operator to read at one glance the pressure, current and wattage on any lamp which may be inserted in a socket immediately above the meter.



"Victor" Lamp-Testing Meter.

The instrument is equipped with three self-contained shunts, one of 150 amperes capacity, having conveniently arranged binding-posts and a 1.5 and 0.75-ampere shunt, which are so connected within the base of the meter as to be readily thrown in circuit at will.

In order to test a lamp it is only necessary to connect the attachment plug and cord to any lamp circuit, insert the lamp and read volts, amperes and watts without computation.

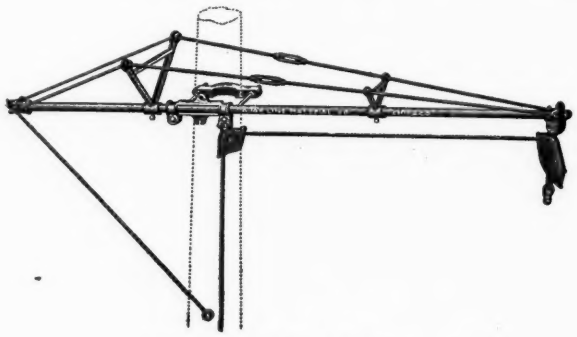
The different shunts may be easily placed in circuit by the adjustment of a small screw-plug at the top and right of the instrument. The two smaller shunts have universal connections.

The voltmeter may have either 150 or 300-volt scale, or both. The most valuable feature of this instrument is the fact that accurate wattage measurement may be taken on a fluctuating load, as it is required to observe but a single point for such readings.

The instrument is entirely self-contained and weighs less than fifteen pounds complete.

A Non-Swaying Mast-Arm.

The gradual substitution of mast-arms for cross-suspensions in supporting street arc lamps has been due chiefly to three reasons. Mast-arms save an extra pole, make the streets more sightly and keep the lamps from swaying. This last has been by no means the least important point, as the ordinary span wire will sway considerably, thus causing the moving shadows which should be entirely avoided in street lighting. The original "side mast-arms," as still used in the New England states, showed all three advantages there, but when tried in the West they did not always avoid the swaying. It was soon found that the high winds of the Central West, acting on the lamp globe at the end of the long truss, would rock the whole fixture on the pole. To prevent this, guy wires were sometimes run from the end of the mast-arm to neighboring trees. More recently such fixtures have been fitted with side braces slipped over the piping and fastened to the pole by lag screws. However, the small rounded edges of these screws have not proven adequate to withstand the strains caused by the wind acting at such a leverage, so the problem has remained a vexatious one.



Ajax "Rigid" Mast-Arm.

Now the Ajax Line Material Company, of Chicago, believes it has solved it in the Ajax "Rigid" mast-arm designed by Albert Scheible and shown herewith. This follows the old New England practice as far as the truss proper is concerned, but adds distinctive western touches in a reinforced tail-cap at one end and a safety pulley at the other end of the fixture. The truss proper is supported at the pole by a plate having two sleeves through which the piping passes and from which heavy bolts run to a girder-shaped strap at the back of the pole. On tightening the bolts the surfaces of this strap are drawn into the pole, thus giving flat bearings to withstand any swaying action of the fixture. The whole mast-arm is easy to erect, and the anchoring device can be readily tightened when the pole gradually dries out and shrinks, so as to maintain the rigidity of the fixture.

"Just" Tungsten Lamps.

Mr. Julius Auerbach, president of the Electrical Accessaries Company, New York city, has returned from his European trip, where he spent six weeks in Budapest and Augsburg in behalf of the "Just" tungsten lamp, which his company is importing into the United States.

Mr. Auerbach is enthusiastic over the progress and numerous improvements made in the quality of these lamps by the different factories.

The Electrical Accessaries Company is now importing a full line of commercial "Just" tungsten lamps in twenty-five, forty and 100 candle-power for 100 and 120 volts, and fifty-candle-power lamps for 200 and 250 volts.

Mr. Auerbach has been successful in making arrangements for large quantities of lamps to be shipped to the United States, and is able to ship promptly any quantity from New York stock. He states that the twenty-five-candle-power lamps will be a great step in advance to make the "Just" tungsten lamps still more popular. The most important developments, of course, are the high-voltage lamps which Mr. Auerbach is bringing over.

Electrical Supplies for the Navy Department.

The Bureau of Supplies and Accounts will open bids in Washington, D. C., January 21, for the following electrical supplies: Miscellaneous supplies for delivery at New York, N. Y.; one five-ton electric truck for delivery at Washington, D. C.

The Electric Machinery Company's Alternators.

The Electric Machinery Company, Minneapolis, Minn., has developed a line of alternating-current generators in three distinct types: Engine type for direct connection to steam or gas reciprocating engines, in sizes from twenty-five kilowatts, at 360 revolutions per minute, to 500 kilowatts, at 150 revolutions per minute; belted or water-wheel type, in sizes ranging from 100 kilowatts, at 900 revolutions per minute, to 500 kilowatts, at 150 revolutions per minute; spherical or self-contained type for small plants, in sizes ranging from forty-five kilowatts, at 1,200 revolutions per minute, to 150 kilowatts, at 900 revolutions per minute. The standard voltages are 250, 500, 1,100, 2,200 and 6,600, and the standard frequencies twenty-five and sixty cycles. These alternators are built for either one, two or three-phase service.

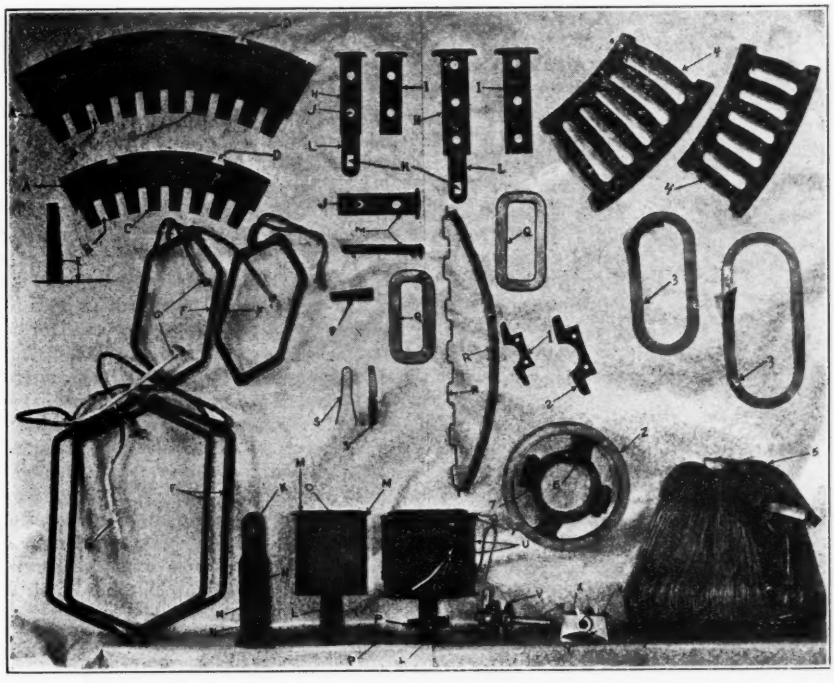


FIG. 1.—PARTS OF ELECTRIC MACHINERY COMPANY TYPE MOTOR.

Particular attention is called by the company to the system of ventilation obtained in the construction of these machines. The revolving field has vents at intervals in the pole pieces which admit cool air from near the shaft up through the pole pieces inside of the field coil. These vents register with vents in the armature core, which are formed of corrugated spacers which obstruct the air very slightly. All alternators are subjected to severe factory tests before shipment.

The stationary armature and revolving-field type of construction is used in all sizes and types of the Electric Machinery Company's alternators. The stationary armature carries the high-voltage winding, and the exciting current of low voltage is carried in the revolving field.

The circular frame is made of iron and is of rigid construction, giving perfect freedom for circulation of cooling air currents. In moderate-sized machines the ring is in one piece, but in very large machines the ring is split horizontally.

Referring to Fig. 1, which shows the assembly of these machines, the armature core is built up of thin steel segments, A. These are punched and notched to receive the coils and dovetailed for rigid supporting. The segments are rolled to remove the burrs, annealed and japanned on both sides. The segments are assembled in the ring frame and clamped between rigid clamping rings. Ventilating spaces are maintained at short intervals in the assembled core by a spacer, R, which it is impossible to displace. An effective toothed support is used at the ends of the core to support the teeth and prevent humming and chafing of the coils. This is a punched steel strip, U-shaped, which allows circulation of the cooling air at the end of each tooth.

The armature coils, F, are wound on forms of double-covered wire, G, without joints, and insulated entirely before being placed in the slots of the armature core. The top of the slot is open, and the coil, with its insulation, may be placed in the slot without cutting and splicing the conductors.

The revolving-field spider is of cast iron or cast steel of high magnetic quality and carries the poles, O, with the field-windings, U. In very large alternators the revolving-field spider is split, but in moderate sizes it is in one piece. In the spider rim are square holes for receiving the pole anchors, L.

The pole pieces are built up of sheet-steel punchings, I, these punchings being assembled on rivets, J and N, between wrought-iron end plates, M, with rounded corners. At the centre of the pole, punchings, H, are used, which have an anchor, L, with a rectangular hole, K, punched in it to receive a retaining key, P. Enough of these punchings are assembled together to form a square which is forced tightly into the square hole in the spider rim.

The field coils are wound of double-covered square copper wire for the small-sized alternators, and of ribbon copper wound edgewise for the larger machines. The coil is placed on the pole before mounting the poles on the field spider, and the face of the pole overhangs on all sides and supports a brass collar, Q, which retains the wire or ribbon copper in place, projecting beyond it and serving as a protection against mechanical injury.

The brush-holder, Y, is of simple design, with two brushes, X, bearing at different angles, so that there is no tendency for the brush-holder to turn on its supporting stud, W. This also gives contact on the rings, Z, at two points well apart, so a flat spot on the ring will not make the voltage fluctuate and lights flicker. For large alternators two or three brush-holders are used on each collector ring.

The bearings of belted and water-wheel, two-bearing and three-bearing type machines, have split sleeves with covered oil-ring grooves and a spherical seat.

A massive base is provided for large alternators, which supports the rings and pedestals on finished surfaces. The pedestals are doweled to the base, but the rings are not. At the inside of the foot of the ring two jack screws are provided, which work against a finished strip on the inside of the base.

Heavy slide rails are provided for belted machines, fitted with lever and ratchet locked together for both rails.

All fields are so designed that they can be fully excited with a 125-volt exciter. The exciters may be direct-connected to the alternator shaft or belted, as may be desired.

Current Electrical News

DOMESTIC AND EXPORT.

TO HARNESS AMAJAC FALLS—Several well-known capitalists of Guadalajara, Mexico, are considering a project to harness the falls of Amajac for the production of electric power. The plan includes the establishment of a large plant to furnish power and light for all neighboring towns.

MINNEAPOLIS WATER POWER LEASED—The Pillsbury-Washburn Flour Mills Company has leased the water power at the New Dam, in the Mississippi at Minneapolis, Minn., to the Minneapolis General Electric Company for twenty-five years. It has taken nearly two years to perfect this new power, which will add 26,000 horse-power to the St. Anthony Falls dams, about which the flour mills are grouped.

BELL TELEPHONE OF CANADA—All arrangements have been completed for the transfer to the Manitoba Government of the entire system of the Bell Telephone Company in the province for a consideration of $3,500,000, payable in four per cent government bonds. The transfer will be completed by January 15. This is a preliminary step to the acquirement of the Bell systems by Alberta and Saskatchewan. As in British Columbia, a public telegraph service is already installed; the telegraph system in the entire West is public.

SUBWAY LINE FOR NEW YORK CITY—The Public Service Commission has approved a new subway route, to be known as the Broadway-Lexington avenue route, and to extend from the Battery north beyond the Harlem river, and thence by two spurs into the Bronx. The commission has also approved a cross-town line on Canal street, designed to connect with the other route, and also with the present system, and to give a connection with the Manhattan Bridge, now building. The cost of the new subways is estimated at $60,000,000. It is believed that the plans will be ready for advertising some time in March. As the city is in no position, however, to construct the subways with its own money, no actual move can be taken until the state legislature amends the Elsberg Rapid Transit law so as to permit of longer term leases, thus making subway building and operation more inviting to individuals.

NEW PUBLICATIONS.

WIRELESS TELEGRAPH STATIONS—The Navy Department, Bureau of Equipment, has published a list of the wireless telegraph stations of the world, including shore stations, merchant vessels and vessels of the United States Navy, corrected to August 1, 1907. The list is arranged alphabetically, according to countries, and gives the name of the station and its location, its call letter, the wave-length in metres, its range in miles, the system, owner, the service intended, and general remarks.

PUBLIC SERVICE COMMISSION—The Public Service Commission for the Second District of the state of New York has issued bulletins reporting on the following subjects: The matter of the complaint of Arthur W. Evans *versus* the Erie Railroad Company; the matter of the petition of Frederick W. Bauer *versus* the Rockland Railroad Company; the application of the Newburgh Light, Heat and Power Company, and the applications of the Lockport Light, Heat and Power Company, the Lockport Gas and Electric Light Company and the Economy Light, Fuel and Power Company. In each of these pamphlets the opinion of the commission is given in full.

NATIONAL ELECTRIC LIGHT ASSOCIATION PROCEEDINGS—The proceedings of the thirtieth convention of the National Electric Light Association, held at Washington, D. C., June 4, 5, 6 and 7, have been published. Vol. I contains a record of the papers, reports and discussions, and is illustrated with a frontispiece bearing the portrait of Arthur Williams. Vol. II contains the commercial programme and the question box. The membership of the association is to be congratulated upon this accession to its literature, and considering the immense amount of material involved, and the thoroughness with which every detail is worked out, the membership is fortunate in securing thus early the complete proceedings.

OBITUARY NOTE.

DR. COLEMAN SELLERS, whose death, on the evening of December 28, was announced in the last issue of the ELECTRICAL REVIEW, was one of the most distinguished engineers with whom the world has been familiar within the last fifty years. Dr. Sellers was born in Philadelphia, Pa., January 28, 1827. His success as a consulting engineer probably reached its greatest height in his handling of the problem presented by the harnessing of the water power at Niagara Falls. At the age of eleven years he entered the academy of Anthony Bolmar, at Westchester, Pa., graduating from the academy in 1844. At the age of nineteen he entered the employ of the Globe Rolling Mills, in Cincinnati, Ohio, operated by his older brothers, Charles and George Escol Sellers. He returned to Philadelphia in 1856, and entered the firm of William Sellers & Company, making tools and similar appliances, becoming a partner of the firm in 1873. He retired in 1888, when the firm was incorporated, the president being his son, Coleman Sellers, Jr. Dr. Sellers was the inventor of a great many tools and made many important discoveries in almost every branch of physics. He was the representative of America on the International Niagara Commission, and acted as consulting engineer for the Cataract Construction Company, and was president and chief engineer of the Niagara Falls Power Company. Dr. Sellers was very active in philanthropic work in his native city, and one of the board of managers of the Franklin Institute. In 1881 he was appointed to the honorary chair of mechanics in Franklin Institute, and was its president from 1870 to 1875. In 1884 he was made president of the American Society of Mechanical Engineers. Besides being a member of the leading engineering societies of this country he was a member of the Institution of Civil Engineers and of the Institution of Mechanical Engineers, of Great Britain. He was also a member of the Geneva Society of Arts. In 1877 the Royal Norwegian Order of St. Olaf was conferred upon him by the King of Sweden, in recognition of his valued services in his profession. Dr. Sellers was a member of the American Philosophical Society, and was one of the founders, and for a time, president both of the Photographic Society and the Pennsylvania Museum and School of Industrial Art, of Philadelphia.

PERSONAL MENTION.

MR. F. L. FULLAM, general superintendent of the Clinton Gas Light Company and of the Leominster Electric Light and Power Company, controlled by the Massachusetts Lighting Companies, has resigned. John F. Madden, superintendent of the Clinton plant, has also resigned.

MR. W. H. OWENS, who has been assistant to Superintendent M. L. Harry, of the Illinois Traction System, at Decatur, Ill., for a year, has tendered his resignation. Mr. Owens will go to his home in Baltimore, Md., for a short time and after will go to Chicago. Mr. Owens has been with the McKinley syndicate about six years.

DATES AHEAD.

Chicago Electrical Show. Coliseum, Chicago, January 13-25, 1908.

International Independent Telephone Association. Annual meeting, Chicago, Ill., January 21, 22 and 23, 1908.

Nebraska Independent Telephone Association. Next meeting, Omaha, Neb., January, 1908.

Wisconsin Electrical Contractors' Association. Next meeting, Milwaukee, Wis., January 15, 1908.

Northwestern Electrical Association. Annual meeting, Milwaukee, Wis., January 15-16, 1908.

Ohio Independent Telephone Association. Next meeting, Columbus, Ohio, March 19, 1908.

ELECTRICAL SECURITIES.

A good deal of underlying strength characterized last week's stock markets, the firm undertone becoming more marked as the week progressed. Monetary conditions steadily relaxed, and while there had been some apprehension concerning monetary restrictions caused by year-end settlements, this worked out very happily. Forecasts as to the immediate future are more conflicting than ever, but there is unanimity on one point: There is little inducement for speculation, and any activity which will be noticed for some time will be in purely investment buying. In many quarters it is felt that the market is in a strong technical position, as the recent declines have brought prices down to basic conditions, and there are no widely extended marginal difficulties under which traders and investors are laboring. In fact, the speculative public is practically out of the market.

Dividends have been declared upon the following electrical securities: Union Traction Company, of Indianapolis; semi-annual dividend of 2/3 per cent on the common stock, payable January 10. National Light, Heat and Power Company, New York; regular quarterly dividend of 1¼ per cent, payable to stockholders of record December 31. Cincinnati, Newport & Covington Light and Traction Company; regular quarterly dividends of ¾ of 1 per cent on the common and 1⅛ per cent on the preferred stock, payable January 15. Jacksonville Electric Company; regular semi-annual dividend of 3 per cent on the common and preferred stocks, payable February 1, to stockholders of record January 14. Railway and Light Securities Company; semi-annual dividend of $3 on the preferred stock, payable February 1, to stock of record January 15. New Orleans City Railway Company; annual dividend of 1 per cent on the common and semi-annual dividend of 2½ per cent on the preferred, payable January 10. Minneapolis General Electric Company; regular semi-annual dividend of 2 per cent on the common stock and 3 per cent on the preferred, payable February 1, to stockholders of record January 15.

ELECTRICAL SECURITIES FOR THE WEEK ENDED JANUARY 4.

New York:	*Closing.*
Allis-Chalmers common	5⅞
Allis-Chalmers preferred	17
Brooklyn Rapid Transit	40⅝
Consolidated Gas	98¾
General Electric	115
Interborough-Metropolitan common	6¾
Interborough-Metropolitan preferred	18
Kings County Electric	85
Mackay Companies (Postal Telegraph and Cables) common	56
Mackay Companies (Postal Telegraph and Cables) preferred	62
Manhattan Elevated	117
Metropolitan Street Railway	20
New York & New Jersey Telephone	102
Western Union	55¼
Westinghouse Manufacturing Company	41¼

The annual meeting of the stockholders of the Consolidated Gas Company of New York will be held January 27 at noon. Books close January 11 and reopen January 28.

Boston:	*Closing.*
American Telephone and Telegraph	101¼
Edison Electric Illuminating	205
Massachusetts Electric	43¾
New England Telephone	105
Western Telephone and Telegraph preferred	53

Philadelphia:	*Closing.*
Electric Company of America	9¼
Electric Storage Battery common	30
Electric Storage Battery preferred	30
Philadelphia Electric	5⅞
Philadelphia Rapid Transit	12½
United Gas Improvement	73¾

Directors of the Electric Company of America have declared the regular semi-annual dividend of 3½ per cent, payable February 3 to stock of record January 10. The board also decided to call a special meeting of stockholders to be held January 30 to authorize the exchange of Electric Company of America stock for the American Gas and Electric Company bonds.

Chicago:	*Closing.*
Chicago Telephone	109½
Commonwealth Edison	80
Metropolitan Elevated preferred	46
National Carbon common	55
National Carbon preferred	100½

The South Side Elevated averaged 119,788 passengers carried daily for the month of December, an increase of 24,576. The average number of passengers carried daily, during December, on the Northwestern Elevated was 105,958, an increase of 11,054; on the Metropolitan Elevated 147,723, a decrease of 8,067.

ELECTRIC LIGHTING.

KENTWOOD, LA.—E. B. Kennon, proprietor of the town electric light and power plant, is making a number of improvements to the system.

ST. PAUL, MINN.—The assembly has accepted the bid of the St. Paul Gas Light Company to furnish both gas and electric lights for street lighting.

HOLYOKE, MASS.—The city lighting department has awarded to the General Electric Company a contract for a $45,000 turbo-generator to be installed in the city lighting plant.

HARRISBURG, PA.—The Eureka Light, Heat and Power Company, one of the recently chartered Philadelphia concerns, has filed an increase of capital stock from $16,500 to $50,000.

RICHTON, MISS.—The electric lighting system recently completed by the Richton Electric Light Company, with S. E. Shannon, of Hattiesburg, manager, has been placed in operation.

WELLES, N. Y.—A mortgage has been filed for $40,000, given by the Broadalbin Electric Light and Power Company to Jeremiah Keck as trustee, to cover the issuance of $40,000 of gold bonds.

PASADENA, CAL.—Instead of the $200,000 which it was originally planned to raise for the enlargement of the municipal electric light plant, the city council has decided to reduce the amount to $50,000. An election for the purpose of voting on the proposition will be held late in January.

MONROVIA, CAL.—The contract for the installation of a new plant at the city wells has been awarded the Edison company by the city council. The price is $11,450. Power is to be furnished at the rate of one cent per kilowatt-hour between 11 P. M. and 6 A. M.; two cents between 6 A. M. and 6 P. M., and three cents for the remaining six hours.

RUTLAND, VT.—At a meeting of the citizens of the village of Moretown it was voted to have the streets of the village lighted by electricity, and a contract has been made with the Moody-Almon company to furnish power for that purpose for a term of five years. An organization was perfected under the name of the Moretown Village Lighting Association.

ATHOL, MASS.—The annual report of the Athol Gas and Electric Light Company shows the following figures: Total assets and liabilities, $129,601.30; capital stock, $50,000; bonds issued, $50,000; profit and loss balance, $28,976.30; operating expenses (gas), $9,488.90; operating expenses (electric), $13,034.12; income, $33,535.73; interest paid, $2,500; dividends declared, $3,500.

LIVINGSTON, MONT.—The Madison River Power Company has petitioned the common council to submit to the voters of Livingston the question as to whether or not the company shall be granted a franchise to furnish light and power. The proposition will be voted on at a special election to be held February 4. The Livingston Light and Power Company has furnished the city light and power for several years.

LEWISTON, ME.—The Auburn Electric Light Company announces that beginning January 1, 1908, the price on meter-rate electric lights in Lewiston and Auburn has been reduced from nine cents per kilowatt-hour to eight cents per kilowatt-hour. Seven years ago the price of lights was twenty cents per kilowatt-hour and the next year was reduced to fifteen cents. At that time the present owners took charge and the price was made ten cents per kilowatt-hour.

SCRANTON, PA.—The Lackawanna Light Company has filed a refunding and extension mortgage on which it proposes to borrow $2,500,000. The United States Mortgage and Trust Company is named as trustee, and the plant on Sanderson avenue, with the machinery and all extensions that may be made in the future, is mortgaged. The company proposes to secure an issue of five per cent gold bonds, due on July 1, 1927, on which interest will be payable January 1 and July 1.

ELECTRIC RAILWAYS.

HAYWARD, CAL.—Charles Heyer, chairman of the town trustees, has signed the ordinance giving the Oakland Traction Company the right to lay double tracks into town over Castro street.

TULSA, OKLA.—Work on the Bartlesville-Dewey interurban railway is now under full headway and the road will be completed in a few weeks. The distance is five miles. This is the first interurban to be built in eastern Oklahoma.

DANVILLE, ILL.—A thirty-year franchise has been granted the Danville & Southeastern Railway Company by the city council. The company purposes connecting with the proposed interurbans from Terre Haute, Clinton and intermediate Indiana towns.

ASHEVILLE, N. C.—Engineers have begun the preliminary survey for the building of the proposed electric road from Asheville to Hendersonville. The contract for the building of this line has been let and it is said that there will be no delay in its construction.

STREATOR, ILL.—The council has granted a franchise to the Chicago, Ottawa & Peoria Railway for the construction of an electric line through Streator. This project is a part of the Illinois Traction System's plan for its road from Ottawa, *via* Morris, to Joliet.

LAWRENCE, MASS.—It is reported that the Southern New Hampshire Street Railway Company has been or is about to be taken over by the Boston & Northern Street Railway Company. The report is that the Southern New Hampshire tracks are to be connected with the Boston & Northern tracks at Hampshire street.

PROVIDENCE, R. I.—The North Smithfield town council has formally approved the franchise renewal made between the town and the New York, New Haven & Hartford Railroad, or the Rhode Island Company, for the running of electric cars through the town. The company is to pay $200 per annum for the privilege, according to the agreement.

UTICA, N. Y.—The first trolley road constructed in the Adirondacks has been placed in operation. This is the line between Lake Clear Junction and Paul Smith's. The new road has been constructed by the Paul Smith's Electric Company and is seven miles in length. The grade is about one per cent, and the route is through one of the finest forests in the state of New York.

WOODBURN, ORE.—Plans are under way for the construction of an electric railway to connect Woodburn with the main line of the Oregon Electric Railway at West Woodburn. Frank Robertson, of Portland, has submitted a proposition for building and operating the road, traffic connections to be made with the Oregon line. It is planned to have the line in operation within ninety days.

ASOTIN, WASH.—Frank McKean is representing the financial interests of a proposed electric railroad. The proposed electric line will be about sixty miles in length, costing in the neighborhood of $2,400,000. In order to carry out the project the property holders are obliged to subscribe twenty per cent of the stock. The company will be incorporated at once, and the work will begin in about six months. It will take two and one-half years to complete the project.

FRANKFORT, KY.—With the announcement that the Evansville & Henderson Electric Railway has increased its capital stock from $10,000 to $100,000 comes the assurance that the proposed line will certainly be built. A decision from the Federal court at Indianapolis on the right of the company to use the Henderson bridge, under the public highways acts of Indiana and Kentucky, is the only thing lacking. The Tennis Construction Company will build the road.

HOLYOKE, MASS.—An order has been issued by the railroad commissioners approving the putting out of 936 shares of additional capital stock, amounting to $93,600 at par value, by the Holyoke Street Railway Company, as an amount reasonably necessary for the cancelation of outstanding bonds issued by the Amherst & Sunderland Street Railway Company, the payment of which has been assumed by the Holyoke company. The board fixes the price of the new stock at $125 per share.

BOSTON, MASS.—The Boston & Eastern Interurban Electric Railroad Company, which desires to construct a high-speed electric line between Boston and Beverly, has filed with the railroad commissioners a petition for a hearing upon its proposed change of route for entrance into Boston. The new plans call for a tunnel beneath the harbor and a terminal station in Post-Office square in place of a physical connection with the Boston Elevated at Sullivan square, which plan was rejected by the commission last summer.

MILLVILLE, N. J.—It is rumored that a Buffalo syndicate will construct a trolley line from Millville to Ocean City next spring and summer. Some months ago a franchise was granted by the council for the proposed work and the right of way was secured from the property owners. The proposed line is thirty-six miles in length—the shortest possible distance from Millville to Ocean City by land. The line will embrace *en route* Cumberland, Hunter's Mills, Head of River, Tuckahoe and Petersburg. The survey has been completed.

DEFIANCE, OHIO—The city council has granted a twenty-five-year franchise to the Haymaker Electric Railway project, which includes the proposed Detroit, Defiance & Fort Wayne and the proposed Defiance, Paulding & Fort Wayne railways. The latter company now owns eight miles of the old Wabash & Erie canal between Defiance and Fort Wayne. The council also accepted the bids of the Toledo, Wabash & St. Louis for carrying passengers through the city. This is the project Charles A. Nauts and C. D. Whitney, of Toledo, and eastern men are interested.

BAY CITY, MICH.—William Perkins and J. Allerdyce, of Detroit, are working to revive the scheme for an electric railway between this city and Detroit. They have purchased the right of way for a portion of the road, which was laid out by the promoters of the Bay City, Caro & Detroit electric line in this county. Perkins & Allerdyce have taken up all the notes which the old concern gave and secured deeds for the right of way. They have also purchased a tract of land near the city limits which will be used for a terminal for their line. Construction work will start in March.

WORCESTER, MASS.—The Worcester & Holden Street Railway has been sold to the Worcester Railways and Investments Company, which is controlled by the New England Investment and Security Company, of Boston. All the old officers were replaced by a new board. The road now becomes a part of the Worcester Consolidated system. The new officers are: President, Francis H. Dewey, Worcester; vice-president, L. S. Storrs, Boston; treasurer, L. Candee, Boston; clerk, J. T. Harmer, Boston; general manager, E. G. Connette, Worcester. The remaining director is B. W. Warren, of Boston.

DENVER, COL.—The Denver-Boulder electric line of the Colorado & Southern Railway will be in operation by May 1. Poles for most of the distance are in place and rails are being laid on some parts of the grade. Pending the building of the Twenty-third street viaduct by the Denver City Tramway Company, over which the electric cars of the Colorado & Southern will enter the city, the cars will come into town over the Globeville tracks of the Tramway. Difficulty in securing structural steel is delaying the construction of the viaduct. Poles have been erected for a branch line to Eldorado Springs from the main line. A half-hour car service will be given the resort during the summer.

SHELBYVILLE, ILL.—The constitution and by-laws of the Mattoon, Shelbyville, Pana & Hillsboro Traction Company, that proposes to run an interurban line between Mattoon and Hillsboro, have been filed. Publication has also been made in the city papers of the franchise that will be asked of the city council permitting the company to run the line the entire length of the main street. It is believed the franchise will be granted as the majority of property owners along the proposed right of way have given their consent to it. The towns along the route have also granted franchises and the right of way is readily being secured. The line, it is expected, will be completed within two years.

ALLENTOWN, PA.—The Slate Belt electric road, running from Nazareth to Bangor, a distance of fourteen and one-half miles, and connecting at the former place with the Lehigh Valley transit road, and at the latter place with the Portland road, has passed into the hands of the bondholders, who effected an organization by electing George K. Moser, of Noxin, Wyoming county, president, and Dennis

G. Gerberich, of this city, general manager. The other officials are still to be appointed. The road was built ten years ago by George H. Wolle, of Bethlehem, and a syndicate of capitalists. It never was a paying concern. The Slate Belt line connects Nazareth, Belfast, Wind Gap, Pen Argyle and Bangor.

BETHLEHEM, PA.—At a meeting of the stockholders of the Slate Belt Electric Street Railway Company arrangements were effected with the bondholders for the settlement of the affairs of the corporation and a reorganization of the company. The resignation of the old board was accepted and the following board of directors was elected: Charles M. Dodson, of Bethlehem; Frank M. Horn, of Catasauqua; A. S. Keck, of Allentown; Walter E. Keck, of New York; George K. Moser, Noxen; W. W. Doughten, of Philadelphia; H. E. Rogers, of New York; Geo. H. Wolle, of Bethlehem; Alan Dodson, of Bethlehem. The following officers were elected: George K. Moser, president; Walter Keck, treasurer; H. E. Rogers, secretary.

RICHMOND, IND.—Another step toward securing through traction service between St. Louis and Pittsburg is about to be taken in the construction of a line from Evansville to Vincennes and Sullivan, where connection will be made with the Terre Haute, Indianapolis & Eastern for points in Eastern Ohio by way of Richmond. James Murdock, former owner of the Richmond line, and Winfield T. Durbin, former governor of Indiana, are interested in the plan. With this link constructed there will remain little to be done to complete the stretch of track from the chief city of Missouri to the chief city of Western Pennsylvania, also affording connection for many important points, notably Detroit, Mich.; Toledo, Ohio; Cincinnati, Ohio, and Cleveland, Ohio.

TACOMA, WASH.—Construction work on the new electric line between Anacortes and Sedro-Woolley has been begun. The work was started in each of the cities, the intention being to complete the terminals first and give each of the cities local traction service ere the connecting link between the two places is built. B. J. Weeks, former manager of the Pacific Traction Company, and general manager of the Anacortes Development Company, which has the building of the Anacortes-Sedro-Woolley line in charge, has been working steadily with a large force of surveyors since early in October laying out the new line and perfecting the mechanical end of its operation. The electric line now under construction will have a length of twenty-two miles, and will drain the commerce of the Skagit Valley. The road will cost about $30,000 a mile and will be completed in thirty months. H. B. Spear, president of the Western Architectural and Engineering Company, of Tacoma, is consulting engineer.

SEATTLE, WASH.—Construction work on the Priest Rapids Railway Company's line, from the Waterville district to Kennewick, along the Columbia river, will begin early next spring. W. R. Rust, president of the company, who is now in Europe, will start the work on his return. The Priest Rapids Railway will be operated by electricity furnished by the big power plant now building on the west bank of the Columbia, seven miles above the proposed crossing of the North Coast and twenty-five miles below the Milwaukee crossing at West Beverly. The power plant, which is owned by the Hanford Irrigation and Power Company, will generate 10,000 horse-power, part of which will be used in supplying water for the new irrigation area. A contract running thirty years has been signed with the Priest Rapids Railway to furnish power for the road. The new electric railway will connect with the Northern Pacific, the Great Northern, the Chicago, Milwaukee & St. Paul, the North Coast and the Portland & Seattle. It will be 136 miles in length when completed. It will run up the Columbia river from Kennewick to the new town of Hanford, crossing the river at Priest Rapids and extend to the Waterville country, tapping the wheat lands of Douglas county and in time will become the principal north and south commercial artery of the state. The surveys of the proposed line have been completed and filed in the United States Land Office. Important stretches of right of way have been secured, so that construction work may begin within a short time. The officers of the company are: W. R. Rust, president; M. B. Haynes, vice-president; E. H. Guie, secretary; H. K. Owens, chief engineer.

NEW INCORPORATIONS.

AUGUSTA, ME.—Monson Light and Power Company, Monson. To furnish gas and electricity. $50,000. President, H. W. Waite, Brookline, Mass.; treasurer, G. F. Barnard, Worcester, Mass.; clerk, F. H. Crane, Monson.

GREELEY, COLO.—The Greeley & Denver Railway Company has filed articles of incorporation with a capital of $50,000. The object of the company is to build an electric railway between Greeley and Denver and into the Crow creek country east of here and furnish electrical power. The road is to run through Weld, Adams and Arapahoe counties. The incorporators are: J. D. Houseman, Max Straus, J. S. Flower, James Williams, H. G. Clark, J. F. Church, all of Denver, and John C. Mosher, B. D. Wyatt, E. J. Decker, G. M. Houston, Mayor Green and John M. B. Petrikin, of Greeley.

NEW MANUFACTURING COMPANY.

BALTIMORE, MD.—The Maryland Railway Supply Company has been incorporated for the purpose of acquiring and developing patented inventions. The incorporators are: Nelson E. Perin, T. Edward Hambleton, Jr.; Thomas D. Claiborne, Thomas W. Boykin and T. Rowland Slingluff, and the authorized capital is $30,000.

INDUSTRIAL ITEMS.

THE DIRECT UNITED STATES CABLE COMPANY, New York city, is distributing to its patrons its customary daily calendar.

THE GERMANIA ELECTRIC LAMP COMPANY, 420 Ogden street, Newark, N. J., has published a new catalogue devoted to standard and reflector types of incandescent lamps.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has issued bulletin No. 78, devoted to transformers. The company manufactures a complete line of transformers for all purposes, all frequencies and all transformation voltages. In addition to the descriptive matter, there is some historical data which will be found of interest to every one concerned in electrical developments.

THE WESTERN ELECTRIC COMPANY, 463 West street, New York city, has issued a very complete catalogue devoted to telephonic apparatus and supplies. This catalogue will be found of great value to those interested in telephone apparatus, as it is really a comprehensive directory of every detail utilized in telephone construction and exchange work. An alphabetical index makes the finding of any article very easy, and there is also a complete index giving list numbers and code words.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., has issued bulletin 2027, entitled "The Hydroelectric Plant at Trinity River, California." This plant is located in the central part of Trinity county, Col., two miles below the town of Junction City. Canon creek, from which the water used for power is obtained, flows into the Trinity river, having a drainage area of fifty-two square miles. The water is delivered to the turbines through ditch sections and open flumes having a total length of 5,250 feet, and a tunnel 1,821 feet long. The plant has an effective head of 600 feet. There are two penstocks, each 1,165 feet long. The power-house is equipped with Allis-Chalmers electrical machinery, consisting of two three-phase, twenty-five-cycle, 750-kilowatt generators, seven step-up transformers and auxiliary. The plant is described very completely in this bulletin, which will be sent upon request to those interested.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., manufactures a complete line of horizontal edgewise instruments for switchboard service, including ammeters, voltmeters, single-phase wattmeters, polyphase wattmeters, frequency indicators and power-factor indicators. Bulletin No. 4551, recently issued by the company, illustrates and describes the various types giving dimension sketches and a complete set of full-sized scales. The wattmeters, power-factor indicators and frequency indicators are constructed on the direct-reading dynamotor principle; the ammeters and voltmeters on the well-known Thomson inclined coil principle. All the instruments are of uniform size, thus giving a pleasing appearance when installed. The horizontal edgewise design has been adopted for the majority of high-grade work, since it was first introduced some years ago. While primarily designed for alternating-current service, the voltmeters, ammeters and wattmeters can be used with good results on direct current.

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VERMONT AND NEW HAMPSHIRE INDEPENDENT TELEPHONE ASSOCIATION. Secretary-treasurer, G. W. Buzzell, St. Johnsbury, Vt.

VERMONT ELECTRICAL ASSOCIATION. Secretary, C. C. Wells, Middlebury Electric Light Company, Middlebury, Vt.

VIRGINIA STATE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, B. L. Fisher, Rocky Mount, Va.

WESTERN ASSOCIATION OF ELECTRICAL INSPECTORS. Secretary, W. S. Boyd, 382 Ohio street, Chicago, Ill.

WESTERN SOCIETY OF ENGINEERS (Electrical Section). Secretary, J. H. Warder, 1737 Monadnock Block, Chicago, Ill.

WISCONSIN ELECTRIC AND INTERURBAN RAILWAY ASSOCIATION. Secretary, Clement C. Smith, president Columbia Construction Company, Milwaukee, Wis.

WISCONSIN INDEPENDENT TELEPHONE ASSOCIATION. Secretary, J. C. Crowley, Jr., Superior, Wis.

Record of Electrical Patents.

Week of December 31.

874,938. MACHINE AND APPARATUS FOR MANUFACTURING FILAMENTS FOR ELECTRIC INCANDESCENT LAMPS. Francis M. F. Cazin, Hoboken, N. J. An exhaustible chamber with concentrically arranged squirting mouths for squirting a core and cover and means for giving the filament its final shape.

874,941. ELECTRIC CLOCK. Ulysses L. Collins, St. Louis, Mo., assignor to Collins Electric Clock Company, St. Louis, Mo. A spring-driven electrically wound clock.

874,944. ART OF ELECTRIC SMELTING. Frank Creelman, New York, N. Y., assignor to the Willson Carbide Works Company of St. Catherines, Limited, St. Catherines, Canada. The heating current is maintained constant independently of internal resistance changes.

874,955. SPARKING MECHANISM FOR EXPLOSION ENGINES. Louis A. Gianoli, Paris, France. A magneto igniter.

874,979. TROLLEY-HARP. William J. Murphy, Bridgeport, Ct., assignor to Frank B. Kennedy, New Haven, Ct. The harp is split for receiving the axle of the wheel.

874,990. MULTIPLE-VOLTAGE SYSTEM OF MOTOR CONTROL. William H. Powell, Norwood, Ohio, assignor to the Bullock Electric Manufacturing Company. The motor field excitation is increased before increasing the applied voltage.

875,017. ELECTRIC TIME-SWITCH. John C. Van Slyke, Fort Collins, Col. A spring-opened, clock-controlled switch.

875,028. TRAIN-STOP FOR ELECTRIC RAILWAYS. Ernst Woltman, New York, N. Y. The potential of any section of the road may be lowered when the signals are set at danger.

875,029. ELECTRIC SWITCH. James J. Wood, Fort Wayne, Ind. A double-break, brush-contact switch, the pressure on the four contacts being equalized.

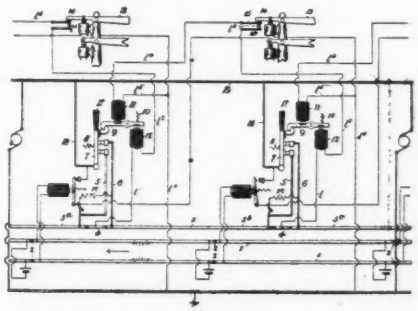
875,030. SWITCH FOR ELECTRIC METERS. James J. Wood, Fort Wayne, Ind. A switch opened by a cam.

875,035. ELECTRICAL IGNITING DEVICE FOR GAS-STOVES. Vincent C. de Ybarrondo, Los Angeles, Cal. A spark igniter.

875,081. TELEPHONE-DICTATING SYSTEM OR APPARATUS. John W. Kelly, Jr., Camden, N. J., assignor to General Acoustic Company. An intercommunicating office system.

875,091. ELECTRICAL ALARM DEVICE. Burnett Menkin, New Haven, Ct. The ringing circuit is closed by a relay controlled by a second circuit.

875,105. ELECTROLYTIC RECEIVER. Fred C. Pickett, Kansas City, Mo. A wire with flattened split end covered with an envelop of viscid material.



875,028.—TRAIN-STOP FOR ELECTRIC RAILWAYS.

875,120. AUTOMATIC ELECTRIC BLOCK-SIGNAL. Wiliam A. D. Short, Lexington, Ky., assignor to Continental Signal Company. A motor-actuated system, the signals being controlled by magnetic clutches.

875,138. TELEPHONE-TRANSMITTER. Christian Umbach, New York, N. Y., assignor to Western Electric Company, Chicago, Ill. The diaphragm and conducting button are attached at an angle.

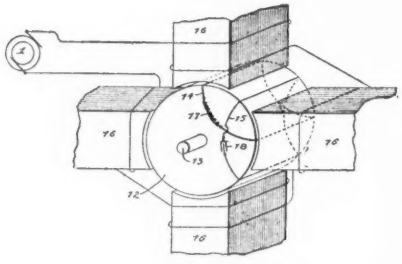
875,156. TELEPHONE-TRANSMITTER. Henry P. Clausen, Chicago, Ill., assignor to American Electric Telephone Company, Chicago, Ill. A double diaphragm transmitter.

875,178. ELECTRIC MOTOR. Dugald C. Jackson, Madison, Wis. A single-phase motor with armature circuits having different time constants.

875,179. ALTERNATING-CURRENT MOTOR. Dugald C. Jackson, Madison, Wis. The armature of a motor, having independent circuits with different constants, is exposed to a single-phase alternating field.

875,198. ELECTRIC BOND FOR RAILS. Frank M. Marcy, Worcester, Mass. The bond is inserted in a pocket in the terminal which is then compressed.

875,205. ELECTRIC REGULATION. Morris Moskowitz, New York, N. Y., assignor to the United States Light and Heating Company, New York, N. Y. A control system for train lighting or similar service.



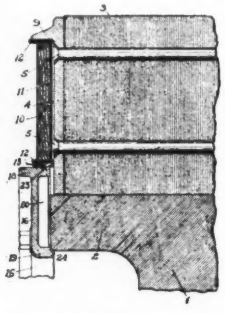
875,178.—ELECTRIC MOTOR.

875,207. FIELD-MAGNET. William D. Pomeroy, Norwood, Ohio, assignor, by mesne assignments, to the Bullock Electric Company. A separately removable compressible seat is supplied for one end of the field coil.

875,213. SECONDARY OR STORAGE BATTERY. Hugh Rodman and George M. Howard, Philadelphia, Pa., assignors to the Electric Storage Battery Company. The active material is made by forming lead or lead oxid containing an insoluble sulphate.

875,215. TROLLEY-POLE. Frederick M. Ross, Newport, Ky. A pivoted trolley base.

875,279. JUNCTION OR CONNECTING BOX. John A. McCoy, Somerville, Mass. The connecting clips project in two channels in the junction box.



875,207.—FIELD-MAGNET.

875,280. ADJUSTABLE HANGER FOR ELECTRIC LIGHTS. James McGavin, Springfield, Ill. The excess cord is wound on a sheave.

875,284. GRANULAR FURNACE. Henry N. Potter, New Rochelle, N. Y., assignor to George Westinghouse, Pittsburg, Pa. The heating resistance is clamped between refractory electrodes and a hollow refractory body passes through the furnace.

875,313. BLOCK-SIGNAL APPARATUS. Alexander Bevan, Providence, R. I. A register is attached to the signal box for indicating the number of cars in the block.

875,357. LAMP-SOCKET. Walter R. Lambert, London, England. A method of construction.

875,376. HANDLE FOR ROTARY SNAP-SWITCHES. Johann G. Peterson, Bridgeport, Ct., assignor to the Perkins Electric Switch Manufacturing Company, Bridgeport, Ct. A spring is contained within the handle.

875,394. ELECTRIC HEATER. August Voelker, Berlin, Germany. A cartridge heater.

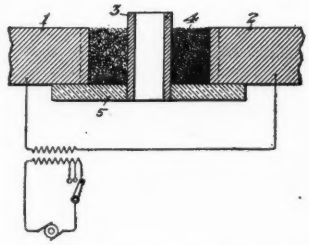
875,406. SWITCH. Christian N. Bergmann, Allegheny, Pa. The blades are inserted in a slot in the holding bar and clamped in place by screws.

875,410. PRINTING-TELEGRAPH RECEIVER. John Burry, Ridgefield Park, N. J. A system utilizing a number of circuits.

875,413. ELECTRIC SIGNALING. Dorabji M. Daboo, Bombay, India. A system for electrically operating signals and track switches.

875,472. INDUCTION-COIL AND BOX FOR EXPLOSION-ENGINES. Richard Varley, Englewood, N. J., assignor to Varley Duplex Magnet Company. A method of constructing an induction coil and box.

875,534. MAGNETO IGNITING DEVICE FOR EXPLOSIVE-ENGINES. Henri de La Valette, Paris, France. An oscillating-field igniter.



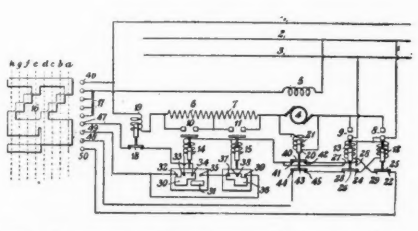
875,284.—GRANULAR FURNACE.

875,581. SYSTEM OF ELECTRIC-MOTOR CONTROL. Henry D. James, Pittsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company. Independently operated switches control the armature resistances.

875,582. MULTI-VOLTAGE SYSTEM OF ELECTRIC-MOTOR CONTROL. Henry D. James, Pittsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company. Manually operated means for selectively governing the operation of starting switches.

875,583. METHOD OF CONTROL OF ELECTRIC MOTORS. Henry D. James, Pittsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company. The motor is switched from one circuit to another without being completely disconnected.

875,584. MULTIPLE-VOLTAGE SYSTEM OF CONTROL. Henry D. James, Pittsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company. A system which prevents the motor from being changed from a high-voltage to a low-voltage circuit until the counter-electromotive force has been sufficiently reduced.



875,583.—METHOD OF CONTROL OF ELECTRIC MOTORS.

875,596. TROLLEY-POLE RETRIEVER. Luther M. Perkins, Tacoma, Wash. A pneumatic retriever.

875,643. PRINTING-TELEGRAPH. John C. Barclay, New York, N. Y., assignor to Western Union Telegraph Company, New York, N. Y. A system operated by pulsatory currents, the printers being controlled by prolonged pulses.

875,660. PRINTING-TELEGRAPH. Frederick J. Haig, Hyattsville, Md. A step-by-step system, the printer returning to the initial position at the end of each signal.

875,663. SYSTEM OF CONTROL. Henry D. James, Pittsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company. A multiple-voltage system in which the voltage applied to the field circuit is increased as the armature is changed from lower to higher potential circuits.